RICE UNIVERSITY

Schema-guided comprehension of noun-noun compounds: An experimental and corpus-based approach

by

Bazile René Lanneau III

A THESIS SUBMITTED
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE

Doctor of Philosophy

APPROVED, THESIS COMMITTEE

Michel Achard, Chair
Professor, Linguistics

Robert Englebretson
Associate Professor, Linguistics

Simon Fischer-Baum
Assistant Professor, Psychology

HOUSTON, TEXAS
OCTOBER 2017

ABSTRACT

Schema-guided comprehension of noun-noun compounds: An experimental and corpus-based approach

by

Bazile René Lanneau III

This dissertation provides evidence that the comprehension of noun-noun compounds is guided by probabilistic knowledge of the structures of things, events, and situations. These structures are what we refer to as “schemas”. As a theoretical construct, schemas are important because they supply information that is not explicitly given. Understanding language involves inference, and this is particularly true for noun-noun compounds.

The constituents of lexicalized compounds are semantically linked in a variety of ways. A *door knob* is a knob that is located on a door, a *wedding dress* is a dress designated for use in a wedding, a *chicken leg* is the leg of a chicken, and so on. The list of relations semantically linking the constituents of noun-noun compounds goes far beyond these Locative, Purposive, and Part-Whole examples. To complicate matters, such relations can be analyzed at varying levels of specificity, creating a trade-off between semantic accuracy and theoretical elegance. Language use therefore offers no deterministic rule for how novel noun-noun compounds should be interpreted. *Cloud house*, for example, could be understood as 'a house in the clouds', 'a house from which

clouds can be seen', or 'a house in the shape of a cloud'. Understanding how such interpretations are constructed would provide crucial clues to how language comprehension works in general.

To that end, a random sample of transparent noun-noun compounds from The Corpus of Contemporary American English is analyzed. Over two hundred examples of noun-noun compounds are provided whose meanings appear to be obvious only in light of schematic world knowledge. Additionally, a series of experiments are discussed which provide evidence that interpretations of novel noun-noun compounds can be biased by abstract conceptual schemas. Through reading tasks, subjects are prompted to build schemas by mapping animals onto roles typically filled by humans in schemas of human activity. Subjects are thus primed to interpret novel compounds of the form Animal-Noun anthropomorphically, e.g., *crab shirt* as 'a shirt worn by a crab'. In conjunction with a broad theoretical discussion, these qualitative and experimental data provide a strong case that schemas play a central role in noun-noun compound comprehension.

Acknowledgements

Earning a PhD is a challenging and at times isolating experience. Like most graduate students, I had doubts along the way and even considered leaving the program. It is thanks to the support of many caring and intelligent people that I was able to complete this dissertation.

I'd first like to thank the faculty at Rice for welcoming me into the department and for challenging me to view language from a variety of thought-provoking perspectives. Special thanks go to my dissertation committee whose guidance and encouragement were instrumental in helping me cross the finish line. My dissertation chair, Michel Achard, consistently posed piercing high level questions which steered me toward crafting a coherent narrative and which helped me explain how my work fits in with the big picture. Robert Englebretson's attention to detail is unparalleled. By incorporating his feedback into subsequent drafts I was always confident that the risk of theoretical or expository blunders had been minimized. Finally, Simon Fischer-Baum provided invaluable input representing the perspectives of psycholinguistics and cognitive psychology. His assistance as a thought partner helped ensure that my experiments and the statistics I used to analyze them were in fact meaningful.

I'd like to thank my classmates at Rice for creating such a friendly and intellectually stimulating environment. My cohort of graduate students in particular (Vlad, Danni, and Steve) brought a generous spirit and a pleasure of learning that made it easy to wake up

excited to learn linguistics each day. Special thanks also goes to Jonas Wittke who made his couch available over the course of the two years that I spent between Austin and Houston. I never anticipated that getting a PhD would involve so much cribbage and so much true crime programming, but I'm glad it did.

Finally, I'd like to thank my friends and family for providing unwavering support throughout my graduate school experience. Being surrounded by people who believe in me made it easier for me to believe in myself. Most importantly, I'd like to thank my partner, Megha, for sharing in my successes and failures along the way. I'm sure I COULD have written this dissertation without you, but it was certainly much easier with you by my side.

Contents

Abstract ii

Acknowledgements iv

Table of Contents vi

List of Figures xi

List of Tables xii

1 Introduction 1

1.1 Why investigate noun-noun compounds? 1

1.2 Research goals and outline 4

2 Previous work on noun-noun compounds 7

2.1 Early accounts: the listing approach 7

2.1.1 Descriptive lists 7

2.1.2 Transformational accounts 14

2.1.3 An early psycholinguistic account 18

2.1.4 Summary 21

2.2 Recent accounts: variations on a scheme 21

2.2.1 Psycholinguistic schematizers: slots and fillers 22

2.2.2 Cognitive linguistic approaches 31

2.2.3 Summary 39

2.3 Opposition to schemas: CARIN and RICE 40

2.3.1 Initial evidence and issues 40

2.3.2 Accounting for property-based interpretations 48

2.3.3 Subsequent iterations 50

2.3.4 Summary 56

2.4 Chapter summary 57

3 The theoretical and explanatory breadth of schemas 60

3.1 Toward social adequacy 62

3.1.1 Dialogic reality of language 62

3.1.2 Linguistic norms among other norms 64

3.1.3 A sociocognitive view of context 66

3.1.4 Summary 68

3.2 Cognitive motivations 69

3.2.1 The inadequacy of set theory 70

3.2.2 Event-based categorization 71

3.2.3 Metaphors 72

3.2.4 Evidence for embodiment 73

3.2.5 Simulation and situation model 74

3.2.6 Good enough processing 76

3.2.7 Cognitive grammar and the co-dependence of form and function . . 78

3.2.8 Mental spaces, blending, and referential ambiguity 79

3.2.9 Summary 80

3.3 The human-centered schema view 81

3.3.1 What schemas are 81

3.3.2 What schemas are not 87

3.3.3 Schemas and noun-noun compounds 89

3.3.4 Testing the model 99

3.3.5 Summary 100

3.4 Chapter summary 100

4 Analysis of lexicalized compounds 102

4.1 Review of theoretical claims 103

4.2 The data 104

4.3 Compound analysis 107

4.3.1 Too many relations 107
4.3.2 Frame semantics of constituents 110
4.3.2.1 Rates and other relational measures 111
4.3.2.2 Dualistic measures 113
4.3.2.3 Words for structures or parts of structures 114
4.3.2.4 Schemas of human activity 116
4.3.3 Relations that are inadequate without schemas 118
4.3.3.1 For/Purpose 118
4.3.3.2 Made Of 121
4.3.3.3 Has/Part-Whole 122
4.3.3.4 About/Topic 123
4.3.4 Inadequacy of relational paraphrase 124
4.3.4.1 Nouns relating to an external schema 125
4.3.4.2 Nominalized verbs imply external relations 127
4.3.4.3 One noun plays a role in the other noun's schema 130
4.4 Chapter Summary 133

5 Experimental evidence for schemas 136
5.1 Experiments 1-3 137
5.1.1 Experiment 1 138
5.1.1.1 Subjects 139
5.1.1.2 Materials 139
5.1.1.3 Design and procedure 140
5.1.1.4 Results and discussion 140
5.1.2 Experiment 2 141
5.1.2.1 Subjects 141
5.1.2.2 Materials 142
5.1.2.3 Design and procedure 142
5.1.2.4 Results and discussion 143
5.1.3 Experiment 3 145

5.1.3.1 Subjects 146
5.1.3.2 Materials 146
5.1.3.3 Design and procedure 146
5.1.3.4 Results and discussion 147
5.1.4 Summary 147
5.2 Experiments 4 and 5 148
5.2.1 Experiment 4 150
5.2.1.1 Norming 152
5.2.1.2 Subjects 156
5.2.1.3 Materials 156
5.2.1.4 Design and procedure 157
5.2.1.5 Initial coding and exclusion of subjects 158
5.2.1.6 Results and discussion 160
5.2.2 Experiment 5 169
5.2.2.1 Norming 171
5.2.2.2 Subjects 174
5.2.2.3 Materials 174
5.2.2.4 Design and procedure 175
5.2.2.5 Initial coding and exclusion of subjects 177
5.2.2.6 Results and discussion 179
5.2.3 Summary 188
5.3 Chapter summary 191

6 Conclusion 196

A Sample of noun-noun compounds 201

B Experiment 1 materials 210

C Experiment 2 materials 211

D Experiment 3 materials **215**

E Experiment 4 materials **218**

F Experiment 5 materials **221**

References **228**

Figures

5.1 Anthro interpretation rate by Species and Task in Experiment 4. 162

5.2 Anthro interpretation rate by Species and Task for High Anthro items in Experiment 4. 165

5.3 Anthro interpretation rate by Species and Task for Low Anthro items in Experiment 4. 166

5.4 Non-Anthro Entity interpretation rate by Species and Task for High Anthro items in Experiment 4. 169

5.5 Anthro interpretation rate by Species and Task in Expreiment 5. 180

5.6 Rate of non-Anthro Entity interpretations by Task and Species in Experiment 5. 187

Tables

2.1 Compound categories and examples provided by Jesperson (1954). 9

2.2 Hatcher's (1960) four categories of compound meaning and examples. A and B refer to constituents in a compound of form AB. 10

2.3 Warren's (1978) prepositional paraphrases for semantic classes of noun-noun compounds and their constituents. 12

2.4 Lees' (1963) list of underlying grammatical relations that motivate compound forms. 15

2.5 Levi's (1978) taxonomy of underlying predicates. 17

2.6 Gagné & Shoben's (1997) taxonomy of thematic relations and examples provided in Appendices. 42

5.1 Anthropomorphic interpretation rate by Item and Species in Experiment 2. 144

5.2 Logistic regression model predicting likelihood of Anthropomorphic interpretation in Experiment 2. 144

5.3 Logistic regression model predicting likelihood of Anthropomorphic interpretation in Experiment 3. 148

5.4 Number of responses coded Anthro for each item in the Experiment 4 norming task that received at least one such response. 155

5.5 Paraphrases of interpretations coded Anthro for each experimental item and rates at which they occurred in Experiment 4. 161

5.6 Mixed effects logistic regression model predicting likelihood of Anthro interpretations in Experiment 4. 163

5.7 Animal-Noun compounds selected for Experiment 5 and norming task interpretation rates. 173

5.8 Interpretations coded Anthro for each experimental item and rates at which they occurred in Experiment 5. 179

5.9 Mixed effects logistic regression model predicting likelihood of Anthro interpretation in Experiment 5. 181

5.10 Anthro interpretation rates by Task and Species by Item in Experiment 5. 187

E.1 Compound lists used in Experiment 4. Experimental compounds are underlined.. 219

Chapter 1

Introduction

1.1 Why investigate noun-noun compounds?

Noun-noun compounds pose a challenge for both descriptive and psychological accounts of language. This productive word formation process, which formally involves the combination of two nouns, produces ambiguity which cannot be predicted by straightforward rules. The constituents of NN compounds can be semantically linked in a wide variety of ways. For example *garage band* is a band that PLAYS MUSIC IN a garage, *roach problem* is an undesired situation INVOLVING THE PRESENCE OF roaches, *bus pass* is something THAT GIVES YOU ACCESS TO a bus, and *toilet paper* is paper SPECIALLY DESIGNED FOR SPECIFIC HYGIENE PURPOSES AFTER USE OF a toilet. For English speakers the meanings of these compounds are intuitive yet there is no semantic pattern among them other than the fact that the compound meaning involves each of the noun concepts. NN compounds are further ambiguous in that a given novel compound can have multiple, qualitatively different interpretations. *Chair box*, for example, could be interpreted as 'a box used as a chair', 'a box that a chair is shipped in', or 'a box that sits next to a chair'.

In contrast, the addition of grammatical morphemes more reliably relates a root's meaning to a word's meaning. Past tense *–ed,* for example, reliably alters the meaning of a verb by signaling that the referenced action occurred before the time of speaking. Slightly

more ambiguous but reasonably constrained is nominalizer *–er*, which when added to a verb, creates a word which can refer to either an Agent who carries out the action referenced by the verb or an Instrument used to complete that activity. Early research on the patterns of meaning in NN compounds attempted to treat them in a way that is analogous to this coarse grained analysis of *–er*. Researchers sought to enumerate the possible relations linking constituent nouns which could result in a compound meaning. Successfully doing so would allow us to view comprehension of novel NN compounds as a relatively simple process whereby a list of potential semantic relations is consulted and one is chosen to form the basis of the compound meaning. NN compounds do not appear to be amenable to such a straightforward analysis. Tidy lists produced by researchers resulted in vague semantic categories into which compounds cannot be placed in a principled manner. Some linguists who attempted to create such lists even concluded that an exhaustive list of possible relations is unachievable. What's more, many NN compounds have meanings which rely on multiple relations between nouns while others do not appear to be based on any relation between the two nouns.

If a list of possible relations is not suitable, then what sort of information is used to understand NN compounds and how is it constrained? All current psychological theories concede that world knowledge is involved, especially when it comes to specific aspects of NN compound interpretation. If *whale cage*, for example, is interpreted as 'a cage for holding whales', it is likely inferred that this cage is larger than most cages, owing to the fact that whales are much larger than the vast majority of cages. Additionally, it might be inferred that such a cage is designed to be partially submerged in water because of the

common knowledge that whales live in water but come to the surface because they breathe air.

A complementary theoretical claim is that the comprehension process is guided by holistic conceptual structures called SCHEMAS. Various operationalizations of schemas, which will be discussed in Chapters 2 and 3, all have in common an appeal to relational structure and the interdependence of concepts. Returning to the domain of whales, our understanding of blowholes is dependent on our understanding of the physical structure of whales and the actions they perform with the blowhole (rising up to the surface to breathe). Our structured knowledge of whale bodies and the events they participate in are co-dependent and can be generalized to help structure the category of 'aquatic mammals'. Schema theories thus emphasize that concepts often exist within a larger organized conceptual structure.

The general theoretical construct of the schema is capable of representing the relational information which appears to form the basis of many compound meanings. Schemas are doubly capable of representing knowledge of noun concepts, such as 'whale', and world knowledge related to such concepts, such as blowholes and surfacing behavior in the case of 'whale'. Despite this theoretical appeal, not all theories assume NN compound comprehension to be schema-based. Those that do posit various mechanisms for integrating schematic information to form new concepts. Those that do not, take a more list-oriented approach where a single relation is chosen to form the basis of a compound's meaning.

The question of whether NN compounds are understood through schemas is a fundamental question that remains unresolved. Though psycholinguistic treatments of NN

compounds often do not present their ideas in terms of broader debates in linguistics, different stances toward the role of schemas correlates broadly with substantive divisions within linguistic theory. The rejection of schemas is broadly consistent with a more traditional "rule-based", computational approach to language while the acceptance of schemas is broadly consistent with the more probabilistic and emergent view of language argued primarily by cognitive linguists (Ryder 1994). Though work on NN compounds alone will not settle broader theoretical debates in linguistics, it can inform them.

Because NN compounds are highly ambiguous, understanding how they are comprehended can shed light on how language is represented and understood generally. The strengths and weaknesses of broad theoretical trends can be empirically tested by attempting to account for extreme cases of ambiguity. Thus, though this dissertation focuses on the role of schemas in NN compound comprehension, it has broader scientific importance for its potential to give evidence for the role of schemas in language comprehension generally.

1.2 Research goals and outline

This dissertation explores the role of schemas in NN compound comprehension through a series of more narrowly defined research questions.

Chapter 2 provides an overview of previous research on NN compounds, and forms the basis for the research questions explored in subsequent chapters. First, a review is provided of attempts to account for NN compound meanings through a finite taxonomy of semantic relations. It explores in detail the shortcomings of this approach as well as the key insights about NN compounds these efforts provide. Next a detailed overview is provided for the

various claims that accounts of NN compounds have made regarding schemas. Differences among schema-based approaches are reviewed as are the general strengths and weaknesses that result from either accepting or rejecting schemas as a component of NN compound comprehension.

Chapter 3 demonstrates the broad theoretical coherence of schemas. First their theoretical breadth is demonstrated by showing the extent to which they apply to social, cognitive, and linguistic phenomena other than NN compounds. Next, a particular approach to schemas, the human-centered view, is developed which integrates findings from both cognitively and socially oriented language research. The framework is them used to demonstrate schemas' ability to provide a more holistic understanding of how NN compound comprehension interacts with social knowledge.

Chapter 4 investigates whether the meanings of naturally occurring compounds can be accounted for without schemas. To that end, a random sample of lexicalized compounds is drawn from the Corpus of Contemporary American English (Davies 2008-). Because the compounds analyzed are lexicalized, the theoretical challenge is to understand what makes their meanings transparent. That is to say, on the basis of what background knowledge is a compound's meaning clearly motivated by the constituent nouns' meanings?

Chapter 5 tests whether abstract conceptual schemas can guide NN compound comprehension. This is accomplished through a series of experiments in which subjects are biased toward anthropomorphic interpretations of novel compounds such as *crab shirt*. Reading tasks are used as primes and experimental conditions differ in only a word or two between such primes. In one condition subjects read descriptions or scenes featuring two characters while in the other, the exact same readings are encountered but with animal

versions of the same characters. This design produces little or no lexical priming and maximal conceptual priming. The human-centered view of schemas predicts that subjects who have just read a passage requiring them to map animals onto roles typically filled by humans in a variety of schemas will be more likely to interpret compounds in a way that is consistent with this schema (*crab shirt* as 'a shirt worn by crabs'). Such effects could not be explained by simple relations between nouns without schemas because the target interpretations span a variety of such relations.

Finally, Chapter 6 provides an overview of the insights provided by the theoretical discussions, corpus analysis, and experimental approaches taken throughout the dissertation. Potential directions for future NN compound research are discussed as are conclusions as to the role of schemas in NN compound comprehension.

Chapter 2

Previous work on noun-noun compounds

This chapter reviews previous work on noun-noun compounds. Special attention is given to accounts that attempt to provide exhaustive lists of possible relational meanings as well as different stances toward schemas and their role in understanding NN compound meaning.

2.1 Early accounts: the listing approach

One approach to handling an ambiguous word formation process is to list the distinct possible types of meanings that the process can create. Nominalizer *-er*, for example, can result in two main types of meanings when added to a verb, Agent and Instrument. This list of two general meaning types is descriptively and psychologically appealing because most words of the form Verb + *-er* can be described as either agentive or instrumental, and there is no particular reason to doubt that people can learn these two meaning types and rely on them to disambiguate novel nominalizations. Early research, however, revealed this approach to be inadequate for describing the semantics of NN compounds or for revealing the processes that enable their comprehension.

2.1.1 Descriptive lists

Jesperson (1954) discusses the wide variety of meanings that can arise from compounding. He shows that such variation can occur even among compounds which share a constituent: a *goldfish* is a fish that looks like gold, a *gold-digger* is one who digs for gold, and a *gold-smith* is someone who works with gold. Perhaps even more semantically contrastive is the example he gives of *home-sickness* versus *sea-sickness*. The former is an undesirable emotional feeling due to the ABSENCE of home while the latter is an undesirable physical feeling caused by the EXPERIENCE of the motion of the sea. Jesperson states that given this unpredictability, it is quite difficult to construct an inventory of "logical relations" that are found in compounds. He even goes on to claim that "[t]he analysis of the possible sense-relations can never be exhaustive" (138).

Though he views the number of relations as potentially endless, Jesperson does describe distinct categories of compounds which express various relations between the constituents. These categories are found in Table 2.1.

After describing these categories, Jesperson claims that there are many compounds which cannot be classified in this way and for which "the relation between the elements is not as simple" (145). Some of the examples he gives are *sunflower*, *sun-dial*, *weathercock*, *rainbow*, *life-boat*, *life-blood*, *fountain-pen*, and *godfather*. Jesperson apparently found the interpretation of *life-boat* as 'a boat for one's life' unsatisfactory, perhaps because this level of description is uninformative as to what a life-boat actually is. Interestingly, Jesperson describes categories of compound meanings which would later be commonly featured in taxonomies, all while maintaining that an exhaustive description of compound meaning types is impossible.

DESCRIPTION OF CATEGORY	EXAMPLES
If the second element is an action- or agent-noun, the first part of the compound may indicate the subject of the action	*sunrise, sunset, childbirth, dog-show, handshake, manslaughter*
The first element indicates the place in which the second is (takes place, etc.)	*garden-party, tombstone, headache, airship, grasshopper*
The first-word denotes the time when what is expressed by the second element happens (appears, etc.)	*nightmare, night-train, evening-star, day-dream, wedding-breakfast*
The first element indicates what the second is meant for	*flagstaff, grass-plot, beehive, keyhole, bedroom, cigar-case*
The first element denotes a tool, instrument, or the like, by means of which the second is brought about	*gunshot, sabre-cut, footstep, handwriting*
The first element denotes something contained in, and thus characterizing, the second	*stone-fruit, feather-bed, sand-paper, mountain-range, newspaper*
The first-word denotes something which the second element resembles	*needle-fish, goldfish, silver-fox, bell-flower*
The first element denotes the material out of which the second is made	*gold ring, stone wall, oatmeal, ironware, railway*

Table 2.1 Compound categories and examples provided by Jesperson (1954).

Hatcher (1960) subsequently argued that Jesperson gave up too soon and that there is unnecessary explanatory overlap among Jesperson's categories. She claims to have created a list of four categories which cover the semantics of all compounds. These categories are found in Table 2.2.

Lumping all compound meanings into these categories requires interpreting the categories quite abstractly and generously. To be fair, Hatcher intended these as general categories that could be subsequently subdivided into finer categories of compound meaning. She does not provide such a subdivision, however, so we can only judge the four

DESCRIPTION OF CATEGORY	EXAMPLES
A is somehow, to some extent, contained, comprehended in B	*gold ring, sandpaper*
A is somehow the source of B	*handwriting, castor oil*
B is contained in A	*broomstick, orange seed*
A is the destination or goal of B	*sugar cane*

Table 2.2 Hatcher's (1960) four categories of compound meaning and examples. A and B refer to constituents in a compound of form AB.

categories on their own merit. As Ryder (1994) points out, even if it were possible to describe all compound meanings using these four categories, the classification system as it stands lacks explanatory power for two reasons. First, the vagueness of the categories makes it difficult in many instances to know which category a compound falls into. Second, it is difficult to imagine using the broadly constructed categories to understand the more specific meaning of a compound. As will be seen in more detail, this is a common problem for finite taxonomies of relations.

Following in Jesperson's footsteps, Marchand (1960) does not attempt to provide an exhaustive list of all possible relations. He notes that though some semantic relations are prominent, such as Material, Purpose, Place, and Time, many compounds cannot be easily categorized in this manner. He in fact surpasses Jesperson's skepticism and questions the value of discretely categorizing the meaning of a compound in general:

> [W]e will always try to classify, but it should be borne in mind that the category of compounding is not one that fills the need for classification. Whether a *nightshirt* is 'a shirt for the night' or 'a shirt worn at night' is quite unimportant. In forming [compounds] we are not guided by logic but by associations … What the relation actually is, very often occurs from the context only. (22)

Marchand suggests that creating a fine-grained list of relational categories and forcing a compound into one and only one of those leads to arbitrary distinctions that, if anything,

obscure the crux of the compound's meaning. He additionally presages the point made by later researchers that NN compounds are highly context dependent and our understanding of them comes from the world.

Marchand makes a further distinction between ENDOCENTRIC and EXOCENTRIC compounds. Endocentric compounds are those which refer to an instance of one of the constituents, which is usually the case. *Toilet paper*, for example, refers to a type of paper. Exocentric compounds do not pick out a referent in this way. Examples Marchand provides are *pickpocket* and *hunchback*, which correspond to the two main types of exocentric noun compounds he discusses. Compounds such as *pickpocket* are of the form Verb + Noun and pick out a (human) agent which Verbs Noun. Other examples Marchand provides are *spilltime*, *pinchpenny*, and *lickdish*. The other main exocentric category are BAHUVRIHI (a term borrowed from Sanskrit) compounds, which are now more commonly known as METONYMICAL compounds. As in the case of *hunchback*, these are compounds which refer to something by referencing a salient feature. Additional examples Marchand provides are *paleface*, *fathead*, and *hothead*. Because most compounds are endocentric and because the semantics of this type can be more easily accounted for compositionally, most semantic descriptions or theories of comprehension of NN compounds exclude exocentric compounds from analysis.

The most detailed semantic analysis of NN compounds is Warren's (1978) *Semantic Patterns of Noun-noun Compounds*. She analyzes 4,557 distinct NN compounds occurring in 180 texts from The Standard Corpus of Present-Day Edited American English. She categorizes NN compounds into six main semantic classes: Constitute, Possession, Location, Purpose, Activity-Actor, and Resemblance. These are each subdivided at up to

three more levels of specificity, creating 54 semantically motivated categories of compounds.

Warren notes that for many but not all of the semantic groupings, a single preposition or small number of prepositions can be used to paraphrase the compound meaning. Warren's prepositional paraphrases, their correlations with semantic classes, and example compounds are found in Table 2.3.

MAIN SEMANTIC CLASS	SPECIFIC SEMANTIC CLASS	PREPOSITION	EXAMPLE
Constitute	Source-Result	*of*	*metal sheet*
	Result-Source	*in*	*sheet metal*
	Copula Compounds	-	*girl friend*
Possession	Whole-Part	*of*	*eggshell*
	Part-Whole	*with*	*armchair*
Location	Place-OBJ	*in, at, on*	*coast road*
	Time-OBJ	*in, at, on*	*Sunday school*
	Origin-OBJ	*from*	*seafood*
Purpose	Goal-Instrument	*for*	*pietin*
Activity-Actor	Activity-OBJ	-	*cowboy*
Resemblance	Comparant-Compared	*like*	*cherry bomb*

Table 2.3 Warren's (1978) prepositional paraphrases for semantic classes of noun-noun compounds and their constituents.

Reducing NN compound semantics to such a small set produces the same problem encountered by previous attempts at listing relations. Some compounds are difficult to fit into any of the categories while others could fall into multiple groups, thus making the categorization somewhat arbitrary. Some of Warren's more problematic categorizations seem to be motivated by either a notably figurative interpretation of the semantic group or an overreliance on the paraphrase structure. For example, one of Warren's subclasses for

Location is Abstract Place-Abstract Entity, in which she places *law degree* and *school days*. Though *law degree* can be paraphrased as 'degree in law' and *school days* can be paraphrased as 'days in/at school', this seems to be more due to the idiosyncratic nature of prepositions than to the spatial sense of *in*. For instance, it seems no more necessary that we say 'degree in law' than the equally plausible 'degree of law'. Furthermore 'days in school' refers to days that children spend in school, not days which are in some abstract sense located in a school. It therefore seems unlikely that Location motivates or adequately describes the crux of our understanding of these compounds. Just as problematic is that this analysis is arbitrary given Warren's categorization of other compounds, such as *pie tin*. Either of these compounds could be lumped into the Purpose class. Just as a pie tin is a tin that enables you to bake a pie, a law degree is a degree which enables you to practice law. Similarly, Warren analyzes *dinnertime* as a purpose relation, presumably because this can be paraphrased as 'time for dinner' or can be thought of as time designated for dinner. It is not clear why *school days* would not receive the same treatment.

Warren's detailed taxonomic approach elucidates the problem of a small set of abstract relations. A compound's correspondence to a semantic category might not mean that that category motivates the meaning of the compound. Rather, it could simply reflect the potential for that category to express one aspect of the compound's meaning. An illustrative example is *gunman*, which Warren analyzes as a Belonging To relation. Though gunmen do have guns, their possession of guns seems particularly inadequate as a description of what a gunman is. After all, very few people who own guns become "gunmen". Using a finite list of general semantic categories reduces the meaning of a compound to just one of potentially many true statements about its meaning.

Warren provides descriptive statistics for how compounds pattern across different categories. One particularly important observation is that Warren only puts 72 compounds in the Resemblance category. The Resemblance category reflects compound meanings that are based on comparison between the constituents. Examples Warren provides are *cherry bomb* and *club foot*. In each case the referent of the compound is an instance of the head noun that is like the modifier in that it shares a physical or perceptual property such as shape or color. As will be discussed in Section 2.3.2, categorizing PROPERTY-BASED interpretations as a subtype of relation is a contentious theoretical route.

Descriptive accounts of the semantics of NN compounds have produced no consensus as to whether it is possible for a finite taxonomy to handle all potential compound meanings. Furthermore, the problems discussed here suggest that even if such a taxonomy were constructed, it would likely be of little explanatory value.

2.1.2 Transformational accounts

Because compounding is a productive process in English, transformational theories must account not only for the semantic variation of compounds but also for rules which derive the compounds from an underlying structure. Lees (1963) attempts this by categorizing noun compounds (including genitive constructions such as *doctor's office*) into groups in which the constituents take different syntactic roles in an underlying structure. Lees' list of grammatical relations and example compounds is found in Table 2.4.

Lees supplemented this list with transformational rules which can be applied to the underlying sentence representation to generate the compound. Lees points out that all the transformations he describes are specific versions of the following rule: $X_1 + X_2 + X_3 = X_3$

GRAMMATICAL RELATION	EXAMPLE COMPOUNDS
Subject-Predicate	*girlfriend, hounddog, menfolk, puppydog*
Subject-"Middle Object"	*artist's model, beeswax, ladies' man, women's college*
Subject-Verb	*blowfly, crybaby, hangman, peptalk, turntable*
Subject-Object	*air brake, cable car, motor cycle, gas stove, locksmith*
Verb-Object	*blowpipe, flashcard, cure-all, pasteboard*
Subject-Prepositional Object	*beehive, bullpen, gopher hole, ice pick, safety belt*
Verb-Prepositional Object	*angleworm, cookstove, payroll, pitchfork, washbasin*
Object-Prepositional Object	*ball club, body shop, cheese cloth, tearoom*

Table 2.4 Lees' (1963) list of underlying grammatical relations that motivate compound forms.

+ X_1. In essence, compounds are derived from an underlying form where the compound's second constituent occurs before the first but with intervening linguistic content. For example, according to Lees, *arrowhead* results from the underlying phrase *head of an arrow*. Semantic ambiguity is thus handled by the fact that underlying forms have the potential for a variety of subsequently deleted material.

Accounting for novel compounds is particularly problematic for this approach. It is not clear how one would know from the compound form which of the underlying forms had produced it. The transformational approach has further difficulty in light of Marchand's example of *nightshirt*, discussed in Section 2.1.1. In the transformational approach, the meaning of a compound relates to one and only one underlying form. This produces an even stricter version of the explanatory shortcomings of the descriptive taxonomies since in a generative approach, underlying forms are not mere paraphrases but are the actual representations of compounds. Similarly, in order to account for the specific meanings of a novel compound, one has to account in a detailed way for the semantics of all the possibly intervening prepositions and verbs in the underlying forms.

Levi (1978) proposes a taxonomy of underlying relations designed to account for what she calls COMPLEX NOMINALS. The category of complex nominals encompasses nominal compounds (*apple cake*, *time bomb*, *nicotine fit*), nominalizations (*Markovian solution*, *American attack*, *city planner*), and noun phrases with NONPREDICATING ADJECTIVES (*electric clock*, *electrical outlet*, *musical criticism*). Nonpredicating adjectives are, as the name suggests, adjectives which either do not appear in the predicate position, or which when doing so, do not convey the same meaning as when in modification position. Using Levi's example from above, *musical criticism* is not criticism that is musical and *electrical outlet* is not an outlet which is electrical. Importantly, nonpredicating adjectives are typically derived from nouns: *musical criticism* is criticism pertaining to music and *electrical outlet* is an outlet for electricity.

Like Lees, Levi proposes transformational rules which can generate the complex nominal forms from underlying sentence forms. But rather than categorize compounds by grammatical relations, Levi claims that a simple list of nine predicates which are deleted from an underlying sentence (typically a relative clause) can account for NN compounds' variety and ambiguity of meaning. Table 2.4 contains Levi's taxonomy of predicates, example compounds, and traditional terms for the relationships expressed by the predicates (provided by Levi). In the first three predicates, Cause, Have, and Make, either constituent can be the head of the underlying relative clause.

A few effects arise from creating such a limited set of predicates. First, many have to be understood quite abstractly. In, for example, expresses a general proximity in space or time between two things. Second, several predicates are similarly ambiguous, For indicating either a purposive or benefactive relation and Have denoting several distinct

senses. Finally, there is the perennial problem of determining which predicate motivates the meaning of a compound, just as we saw with descriptive lists of relations. Levi analyzes *field mouse* with the In relation, but a field mouse could similarly be thought of as 'a mouse that a field has', or as 'a mouse that is from a field'. Similarly, if *voice vote* is created via Use, why isn't *picture book*? Votes use voices no more than books use pictures. Likewise, why not analyze *voice vote* as an instance of Make?

PREDICATE	EXAMPLE COMPLEX NOMINALS	TRADITIONAL TERM
Cause	*tear gas, drug deaths, mortal blow, thermal stress*	causative
Have	*picture book, gunboat, lemon peel, reptilian scales*	possessive/dative
Make	*honeybee, silkworm, snowball, molecular chains*	productive; constitutive, compositional
Use	*voice vote, manual labor, vehicular transportation*	instrumental
Be	*soldier ant, target structure, professorial friends*	essive/appositional
In	*field mouse, morning prayers, marital sex*	locative [spatial or temporal]
For	*horse doctor, arms budget, nasal mist*	purposive/benefactive
From	*olive oil, test-tube baby, solar energy*	source/ablative
About	*tax law, price war, criminal policy*	topic

Table 2.5 Levi's (1978) taxonomy of underlying predicates.

Ryder (1994) points out that an additional limitation of Levi's taxonomy is its inability to account for compounds motivated by analogy to other lexicalized compounds. *Angora rabbit*, for example, is motivated by the salience of the animal's hair which is silky like the

hair of an *Angora goat*. Angora goats get their name because they originate from Angora (Ankara). But no such location relation accounts for *Angora rabbit*.

Levi's taxonomy was meant only to encompass endocentric compounds with literal meanings. Even within this restricted set there are plenty of compounds that do not fit into the taxonomy, as will be discussed in Section 2.1.3. Some such compounds do not even have meanings which can be adequately characterized as a relation between nouns at all. These include the compounds with property-based interpretations mentioned in Section 2.1.1. Examples of such compounds are *bullet train* (a train that is fast like a bullet) and *orange soap* (soap with the smell of oranges).

Transformational taxonomies do not demonstrate that generative syntax can handle NN compounds. To be taken seriously as a psychological theory, they would need to overcome the predictable problems with finite taxonomies while also demonstrating the psychological validity of deletions and transformations from an underlying structure.

2.1.3 An early psycholinguistic account

Downing (1977) provides an early test of the psychological viability of finite taxonomies of NN compound semantics. She focuses primarily on the meanings of nonlexicalized compounds in order to "avoid entanglement with the historical process" (824). The entanglements Downing refers to are the highly specific aspects of compound meaning which emerge through lexicalization and which cannot be attributed to general semantic relations. An example she provides is *lipstick*, which is understood as much more than simply 'a stick for the lips' and contains semantic information which is not necessarily invoked by either constituent. Downing analyzes the observable semantic patterns in NN compounds using four sources of data: the semantic relationships in NN compounds in

various corpora (description task data, newspapers, and novels); results from a naming task in which participants provided names for entities found in illustrations; interpretations participants provided for NN compounds encountered in isolation; results from a ranking task in which participants judged the appropriateness of interpretations for NN compounds.

Downing states that her analysis does not extend to DEICTIC compounds, which are compounds created within a specific conversational context in order to efficiently reference an established entity. An example Downing gives is *the apple-juice seat*, which was reportedly used to refer to a seat with apple juice in front of it. Such reference is clearly not intended as a suggestion of a general category of seats with apple juice in front of them.

Downing reports apparent constraints on how relational meanings can contribute to novel NN compound interpretations. Compounds consisting of semantically related words such as *butler-maid*, *circle-square*, *fork-spoon*, and *loaf-pie* generally did not elicit interpretations which describe a relation between the two constituents. In the evaluation of potential compound meanings, "interpretations based on a denial of proximity between the members of the compound" (824) were strongly dispreferred. A few such compound interpretations were unanimously judged impossible: *cousin-chair* as 'a chair reserved for non-cousins'; *egg-bird* as 'a male bird'; *fork-spoon* as 'a spoon that does not match the fork'. Another key constraint Downing discusses is redundancy. Many participants could not provide an interpretation of *book-novel* for example, and those who did, did so by finding a nonredundant interpretation, such as 'a novel about book writing'.

Crucially, Downing finds little evidence for a finite list of relations which could form the basis of NN compound interpretations. Though the relations/predicates found in the taxonomies of Lees (1963), Li (1971), and Levi (1975) apply to many of the interpretations

analyzed, Downing notes that for some compounds it was only with great difficulty that she was able to choose a category. Examples of such interpretations are *cow-tree* as 'a tree that cows like to rub up against', *egg-bird* as 'a bird that steals other birds' eggs', and *pea-princess* as 'a genuine princess, who passes the test of a pea under 20 mattresses'. Downing explains that categorizing interpretations according to a fixed taxonomy is made all the more difficult by the specificity of many of the interpretations created. Examples Downing provides are *frog-slime* as 'the slime that frogs exude to keep from dehydrating', *dinner-bath* as 'a bath taken to prepare for dinner', and *oil-bowl* as 'the bowl into which the oil in the engine is drained during an oil change'. Though it is true that these interpretations could be respectively characterized as instances of Make, Time, and For relations, doing so does little to explain the specific meanings that participants generate. The explanatory power of finite sets of relations is unsatisfactory both because the vagueness of relations often precludes principled categorization and the abstract level of meaning which the relations describe fails to capture the crux of participants' actual understandings.

Downing provides rankings of frequencies of common interpretation types across the different sources of data. For the purpose of these rankings, Downing proposes the interpretation category of Comparison, which essentially correlates with property-based interpretations. Regardless of the merits of analyzing property-based interpretations in relational terms, Downing provides interesting insights into the varying rates of this type of interpretation found across different sources of data. She notes that such meanings are rare for the compounds attested in corpora but were not uncommon in the compound interpretation task. She suggests that this could mean the comparison-based interpretations are normally a strategy of "last resort" and that participants rely on this type of strategy at

a higher rate when interpreting a compound in isolation because there is not enough contextual information to suggest one of the other relations.

Downing's use of corpora and experimental data puts her conclusions on firmer empirical ground than prior accounts, while providing further evidence for the futility of listing.

2.1.4 Summary

Attempts to account for existing and potential meanings of NN compounds with a list of relations were unsuccessful. A complete list of NN compound meanings appears elusive while tidy lists which describe the majority of compound meanings at a general level fail to capture the specific interpretations people generate. Such lists often result in an inability to categorize a compound in a principled manner. These observations motivate questions which more recent accounts of compounds attempt to explain. Do common semantic relations motivate specific meanings or are these general relations epiphenomenal? Where do the specific nuances of compound interpretation come from? What sort of representations best characterize lexical and conceptual knowledge and what processes enable us to understand novel compounds? What are the roles of general world knowledge and knowledge of language use? Do different processes motivate relation- and property-based interpretations, and if so, do these occur serially or in parallel? These issues and more are addressed in Section 2.2.

2.2 Recent accounts: variations on a scheme

The questions raised by early research on NN compounds have been taken up by linguists and psychologists alike. A common theme across their theories is an orientation toward schemas, either utilizing the concept or actively claiming that they are not involved in compound comprehension. There are exceptions, such as Lynott and Connell's (2010b) embodied approach and Costello and Keane's (2000) theory of pragmatic constraints, but these are not at odds with the key claims of schema theories. Across recent theories of NN compounds different operationalizations of schemas have emerged, and sometimes as a result, so have false dichotomies. Despite their differences, all schema-based theories of NN compounds share the view that some concepts involve holistic structures in which there are roles and relations between those roles. A simple example is the RESTAURANT schema, which represents our understanding of and expectations about the structure of events that take place in restaurants. This structure involves specific roles, such as patrons and waiters, as well as subroutines like ordering and paying, through which such roles are constructed and understood. In short, the import of schemas is their appeal to structured knowledge and the implied conceptual interdependence between parts of such knowledge. This section reviews recent theories of NN compound comprehension, the variety of stances toward schemas, and the evidence used to support their claims. Particular attention will be paid to the assumptions made by theories which claim that NN compounds are not interpreted via schemas.

2.2.1 Psycholinguistic schematizers: slots and fillers

Psycholinguistic approaches to NN compound comprehension have often been subsumed under broader theories of CONCEPT COMBINATION. In psycholinguistics the term "concept combination" is often used to refer to adjective-noun and noun-noun pairs. This conflation

of form and function reflects the traditional bias in psychology and linguistics of viewing linguistic meaning as the sum of truth conditional values of component structures. It was expressly as a challenge to this view that the SCHEMA MODIFICATION THEORY (Murphy 1988, 1990) of concept combination was created.

The schema modification view inherits a concept of the schema from Rumelhart (1980), which Murphy (1990) operationalizes as a "structured set of slots and fillers" (261). In the schema modification model, head nouns in modifier-noun pairs are represented as schemas. They provide these schemas to the combined concept while the modifier (whether adjective or noun) fills a slot in that schema. An example Murphy (1988) discusses is how schema modification would represent the meaning of *apartment dog*. One element of our schematic knowledge of dogs is that they are living things and typically live with people in a human dwelling. Thus, 'apartment' easily fills the slot of 'habitat' in the DOG schema. What this sort of representation allows is for our structured knowledge about the head noun concept to inform interpretations of novel concept combinations. One advantage of this view over the taxonomic approaches discussed earlier is the specificity of interpretations that the process can motivate. Rather than reduce the meaning of *apartment dog* to a simple Location relation, our knowledge of dogs and the salience of habitats motivates our understanding that it is specifically a dog that LIVES in an apartment. Another advantage of appealing to world knowledge is that this knowledge can further elaborate the meaning motivated by slot-filling. Murphy explains that our knowledge of dogs and apartments could lead us to infer that an *apartment dog* is likely to be smaller or quieter than a dog that lives on a farm. Conceptual elaboration motivated by world knowledge provides a basic explanation for where inferences about concept combinations come from.

As the example of *apartment dog* illustrates, schema modification's reliance on general world knowledge allows features to emerge which are not part of either constituent concept of a compound. This contrasts with the more traditional view of meaning construction, which Murphy (1988) calls FEATURE WEIGHTING, where feature likelihood is inherited directly from one of the constituents. Murphy (1988) reports two experiments which test these opposing views. If the feature weighting view is correct then typicality judgments of a feature for a given noun should be the same in bare noun and modifier-noun contexts. The first experiment tested this hypothesis by having subjects rate the typicality of properties for a concept combination and for its respective head noun in isolation. As an example, participants judged the typicality of 'emits lots of black smoke' for both *smelly trucks* and *trucks*. The ratings were significantly different between the bare noun and concept combination conditions. The second experiment tested another assumption of the feature weighting model, the PRINCIPLE OF CONSISTENT MODIFICATION. In this view, adjectives should be consistent in the type of information that they bring to a concept combination. Murphy tested this hypothesis by having subjects provide interpretations of adjective-noun pairings, varying the noun that a given adjective is paired with by generating all of the possible pairings between a list of ten adjectives and ten nouns. Adjectives included *long*, *good*, and *new* while nouns included words such as *year*, *people*, and *problem*. Adjectives did not appear to have stable meanings across different adjective-noun contexts. As Murphy observes, "[a]lthough it would be easier if words like *long* had the same effect regardless of what they modify, natural language does not seem to work this way" (553). The specific type of information a given adjective contributes to a concept combination interacts with the structure of the head noun concept. Results from the two

experiments contradict the traditional atomistic approach to meaning while providing support for schema modification.

Murphy (1990) further tests schema modification theory in a series of experiments contrasting the relative difficulty of understanding different concept combinations. Schema modification predicts that the ease with which a modifier-noun pair can be understood is related to how easy it is to find a slot in the head noun which the modifier can fill. NN compounds would be expected to be relatively difficult to interpret because the modifying noun does not, on its own, suggest a particular dimension that it should modify or a particular slot that it should fill. This is as compared to an adjective such as *green*, which can be integrated with most head nouns by finding some aspect of the noun concept that is not colorless. In one experiment, Murphy ran two tasks on a set of modifier-noun pairs. One group of participants rated the difficulty of finding an interpretation for each pair. Another group of participants completed a timed task on the same materials in which they decided whether a modifier-noun pair did or did not have a sensible meaning. The three experimental conditions were Typical Adjective (*edible food*) Atypical Adjective (*inedible food*) and Noun-Noun (some random pairing of two of the nouns from adjective-noun pairs). Consistent with the slot-filling view, items were rated more difficult to understand and response times were longer going from Typical Adjective to Atypical Adjective to Noun-Noun condition.

In schema modification, the salience of different slots in a schema affects the slot-filling process. Combined concepts in which a modifier picks out an aspect of a head noun's schema which is not normally salient are expected to take longer to process than those where the modifier fills a salient slot of the head noun. Murphy (1990: Experiment 3) tested

this prediction via the same sense/nonsense task used in the first experiment. Here Typical and Atypical adjectives were compared (*cold beer* vs *hot beer*) and those same adjectives were paired with a noun that would produce an "irrelevant context", such as *cold garbage* and *hot garbage*. Garbage provides an irrelevant context for temperature because we in theory do not typically attend to the temperature of garbage. Response times were more than 500 ms slower in the irrelevant context than in the relevant context.

Basic predictions of schema modification bear out experimentally. Properties of combined concepts are not a mere sum of the two constituents' properties nor do they correspond to either individual concept in a one-to-one fashion. The sort of information an adjective contributes interacts with specific knowledge about the noun being modified. The salience of a particular dimension in a noun's schema affects the ease with which concepts can be created which specify some quality along that dimension. Schema modification also provides explanatory power for NN compound semantics. Whereas taxonomies require arbitrarily reducing a compound's meaning to an abstract semantic relation, slot-filling provides an explanation for how fuller knowledge of compound meanings are stored and how specific interpretations of novel compounds are possible.

Though schemas and the slot-filling mechanism have clear potential to shed light on NN compounds, Wisniewski & Gentner (1991) uncovered limits to their explanatory power by having participants interpret a variety of NN compounds in isolation. They report that though slot-filling explains many of the interpretations, there were plenty of counter examples which point to the need for additional processes and more complex schematic representation. Raters judged a full 30% of interpretations to be property-based interpretations which cannot be modeled in terms of the modifying noun's unaltered

concept filling a slot in the head noun's schema. Wisniewski & Gentner argue that a combination of two processes, PROPERTY MAPPING and STRUCTURE MAPPING, account for property-based interpretations. Property mapping is a process whereby a property of the modifying noun fills a slot in the head noun's schema. An example Wisniewski & Gentner provide is *robin snake* interpreted as 'a red snake'. In this case the salient color of a robin fills the color slot in the SNAKE schema. Structure mapping on the other hand involves more complex connections between the constituents. Wisniewski & Gentner use *pony chair* interpreted as 'a small chair' as an example. This might at first seem like a case of property mapping where the feature 'small' is mapped onto the size slot of the CHAIR schema. But this neglects the fact that 'small' is a relative concept. Interpreting *pony chair* as 'a small chair' requires mapping structured knowledge of horse sizes onto the category 'chair' and connecting ponies with a hypothetical subclass of chairs. Wisniewski & Gentner conclude that schemas can account for interpretations of novel NN compounds but that doing so requires processes beyond slot-filling.

Wisniewski (1996, Experiment 2) provides evidence that property-based interpretations can be explained by a general comparison process in which the two constituents of a NN compound's respective concepts are compared. One of the predictions of this view is that if two nouns are more similar, a difference between them can become more salient and a property-based interpretation motivated by that difference is more likely. Wisniewski tested this claim by having participants provide an interpretation of NN compounds in isolation. The compounds selected were generated by creating a Similar and Dissimilar condition compound for each head noun. In the Similar condition, the head noun was paired with a modifying noun that was semantically similar to the head noun. In the

Dissimilar condition, it was paired with a semantically dissimilar modifier. Examples of Similar and Dissimilar pairs are *bus truck* and *knife truck* respectively. The predicted results were obtained and property-based interpretations were significantly more likely in the Similar condition (72%) than the Dissimilar condition (48%). Additionally, relation-based interpretations were much more likely for Dissimilar items (52%) than Similar items (7%). Nearly all other interpretations were categorized as HYBRID interpretations where the compound is understood as having properties of each constituent. The rates of interpretation types were taken as evidence that two main processes, relation-linking and a comparison process, are responsible for NN compound interpretations.

Wisniewski (1997) incorporates these observations into the AUGMENTED SCHEMA APPROACH. In this approach, relation-based interpretations arise from SCENARIO CREATION while property-based interpretations arise from COMPARISON AND CONSTRUCTION. In the augmented schema approach, scenarios are also represented schematically with representation of relations among slots and typical fillers for those slots. Wisniewski explains this process with the example of *truck soap* which can be interpreted as 'soap for cleaning trucks'. In the augmented schema approach, 'truck' and 'soap' fill slots in a general CLEANING schema rather than 'truck' simply filling a slot in the schema for SOAP. In this CLEANING schema, there are slots for 'cleaning agents' and for 'things being cleaned' which 'soap' and 'truck' fill respectively.

The comparison and construction process describes how property-based interpretations emerge. The constituents of a NN compound are compared and detection of differences and similarities help inform what property could potentially be mapped onto the head noun. Wisniewski gives the example of *zebra clam* as 'a clam with stripes'. Whereas in relation-

based interpretations a scenario is created in which the two noun concepts are related somehow, in property-based interpretations it is a new thing altogether which can be constructed. The construction process is perhaps even more evident in hybrid interpretations, which Wisniewski (1996) views as extreme versions of property mapping. Wisniewski (1997) gives the example of *fork spoon*, understood as a multi-function utensil with both prongs and a "little bowl" at the end. Such a construction emerges from comparing the FORK and SPOON schemas and analogously aligning their handles and their function oriented ends. Importantly the resulting concept does not have the same sort of prongs or little bowls found on forks and spoons. The prongs are probably shorter and the edge of the little bowl is not smoothly rounded because of the prongs. The augmented schema approach thus accounts for the fact that concepts often change when they are combined. Wisniewski (1997) argues that schema-based approaches are superior to approaches which view meaning as motivated by a general semantic relation between constituents because it is able to account for a finer level of specificity of meaning. This of course mirrors the previous discussion of the shortcomings of finite taxonomies.

According to the augmented schema approach, relation- and property-based interpretations arise from distinct processes, but it is not assumed that the processes have a predefined serial ordering. Instead, Wisniewski (1997) suggests that the comparison process motivates the choice between a scenario creation or a construction strategy. Shoben & Gagné (1997) on the other hand have claimed, like Downing (1977), that property-based interpretations are created only as a "last resort", after a relation-based interpretation has been attempted. Wisniewski & Love (1998) tested this LAST RESORT HYPOTHESIS. In their first experiment they created pairs of compounds which shared a constituent but differed

as to whether the constituents of each compound were semantically Similar or Dissimilar to each other, e.g. *goose vulture* and *fish vulture*. For each pair, interpretations were created for each compound using a particular relation. For example, 'a vulture that eats dead geese' and 'a vulture that eats dead fish' for *goose vulture* and *fish vulture*. A rating task verified that the situational plausibility of the interpretations were higher for the Similar constituent pairs than the Dissimilar constituent pairs. Participants then interpreted the NN compounds that formed the basis of the scenario comparisons. The Similar constituent items were more likely to be given a property-based interpretation than the Dissimilar constituent items despite the fact that there was a plausible relation-based interpretation. The last resort hypothesis cannot explain these results because with the availability of a plausible relation-based interpretation, there would be no reason to abandon that strategy and attempt a property-based interpretation.

In a second experiment, Wisniewski & Love demonstrated that relation- and property-based interpretations could be differentially primed. Participants interpreted a list of prime compounds and then a list of target compounds. Three different lists of primes were used. In the Property and Relation lists, prime compounds were constructed which were more likely to be given property- and relation-based interpretations respectively. For items in the Neutral list, the preference for relation- or property-based interpretations was not controlled. Going from the Property to Neutral to Relation prime conditions, relation-based interpretations reliably increased and property-based interpretations reliably decreased. If relation-based interpretations must be attempted before property-based interpretations, such priming effects should not be possible.

Finally, Wisniewski & Love analyzed over 1000 NN compounds from a variety of sources. They found 29.1% of the compounds to have property-based meanings. They take this as evidence that property-based interpretations are not as uncommon in production as previously thought and that there is not a particular bias toward relation-based interpretations. It is difficult to assess the precision of their measure, however, as they do not provide a full list of compounds and how they were analyzed.

The psycholinguistic operationalization of schemas as structured lists of slots and fillers shows explanatory promise. Schemas capture specific organized knowledge about noun concepts and about the world in general. Slot-filling and other mechanisms are therefore capable of accounting for the interpretations that people provide for novel NN compounds at a finer level of detail than general semantic relations can. In Rumelhart's (1980) view, schemas are the building blocks of concepts in general. It seems odd, therefore, that schema modification limits the role of schemas to merely representing the head-noun concept. The augmented schema approach demonstrates that complex representations of both constituents are necessary, that a process other than slot-filling is needed, and that NN compounds might be interpreted by filling slots in an associated schema with the constituents.

2.2.2 Cognitive linguistic approaches

Frameworks in cognitive linguistics have also been developed to take advantage of the explanatory power of schemas. They have most commonly taken inspiration from Fillmore's (1982) FRAME SEMANTICS. Fillmore uses *frame* to mean "any system of concepts related in such a way that to understand any one of them you have to understand the whole structure in which it fits" (111). An example Fillmore gives of how this applies to lexical

meaning is *weekend*. The term makes sense for members of a society that organizes life around a seven day week cycle and in which people typically dedicate five days to public work and two days to private life. Frame semantic analysis, however, is not limited to lexical meaning. Fillmore asserts that frames can reveal principles behind word and phrase creation and explain how the meanings of words and phrases can be integrated to construct the whole meaning of a text. Thus frame semantics provides a wider application of schemas to language meaning and comprehension than the psycholinguistic approaches discussed. It is additionally less formal, relying more broadly on the notion of interdependent concepts than on ideas like lists of slots and fillers. What frame semantics shares with the schema-based treatments of concept combination in psycholinguistics is the ability to explain NONCOMPOSITIONAL aspects of meaning through structured knowledge of typical things and events in the world.

The best known frame semantic treatment of NN compounds is Ryder's (1994) theoretical and experimental work in which she assumes Langacker's (1987, 1991) framework of COGNITIVE GRAMMAR (CG). CG goes beyond frame semantics and treats all aspects of language schematically, including morphological and syntactic structure. CG claims that language users abduce syntactic schemas at various levels of specificity which motivate their understanding of what is grammatically acceptable in a language. For example, in place of an abstract rule which generates all possible noun phrases, it is assumed that language users detect a wide variety of syntactic combinations which are learned as acceptable instances of nominals. English speakers know that potential nominal forms include Determiner + Noun, Determiner + Noun + Prepositional Phrase, and Determiner + Adjective + Noun + Prepositional Phrase because they have observed that

phrases of these forms can behave similarly in relation to other syntactic structures. In CG, syntactic schemas can also be embedded, with one schema acting as a component of another, thus accounting for recursive properties of grammatical form.

Unlike generative approaches to syntax, however, CG views form and meaning as inherently connected and mutually conditioning. In this way, CG is a type of CONSTRUCTION GRAMMAR (Lakoff 1987; Fillmore et al. 1988; Goldberg 1995), in which morphological and syntactic forms are associated with schematic conceptual representations of varying levels of specificity. One of the most commonly cited illustrations of this idea is Goldberg's (1995) sentence, *He sneezed the napkin off the table*. This sentence instantiates the caused-motion construction which pairs the syntactic form of Subject + Verb + Object + Oblique with the schema of force being applied to an entity and causing it to move. The syntactic form is understood to motivate the meaning of the sentence because if it didn't, we would have to assume that English speakers have previously learned a transitive sense of *sneeze*. This would conflict with our knowledge of typical sneezing events and with our knowledge of the use of *sneeze*. Crucially, making sense of the sentence is also dependent on our knowledge of the degree of force a sneeze produces as well as the amount of force that would be required to move a napkin. Of course, not all sentences of this syntactic form will be understood as instances of the caused-motion schema. In *He ate a hotdog in the kitchen*, for example, *ate* is not readily interpreted in a force-dynamic way especially when taking *hotdog* as an object. In contrast, the top-down association of this sentence form with caused-motion scenarios is what motivates the grammatical acceptability and our interpretation of *He sneezed the napkin off the table*.

Ryder's (1994) work on NN compounds utilizes these views as well as Langacker's often repeated refrain that "schemas are immanent in their instantiations" (2008). This idea again highlights that constructional schemas are not simply imposed in a top-down manner. They are abduced by language users based on their experience of language, and as such, they can be represented at various levels of specificity. *Table tennis*, for example, is not only an instance of a NN compound, it also constitutes a construction in its own right and thus can potentially motivate the production and interpretation of other compounds. Taking this perspective, Ryder is concerned with the frequency of compound types and the effect it has on subjects' interpretation of related NN compounds.

In search of such frequency effects, Ryder examined NN compounds found in *American Heritage* and *American Heritage Word Frequency Book* (1971). Within these compounds, Ryder looks for special types of schemas that she calls LINGUISTIC TEMPLATES. Linguistic templates can be either specific phrases or patterns across phrases that provide an analogy base for interpreting novel phrases. An example of a compound motivated by another specific compound that Ryder gives is the term *ice legs* which one is said to have if one knows how to walk on ice without falling. This term is motivated by the term *sea legs.* Phrasal pattern templates can emerge if a certain word is often encountered in the same position of many NN compounds, and if that word frequently has the same relationship to the other noun. An example Ryder gives is *sea* + Noun where the second noun refers to something that lives on land (*sea lion*, *sea cow*, *sea weed*, etc.) and the compound refers to a metaphorical version of that thing that lives in the sea. The salience of linguistic templates for language users would be demonstrated experimentally if it can

be shown that they prefer to interpret a novel NN compound along the lines of the linguistic template that motivated its construction.

Ryder designed experiments intending to show that people do in fact attend to linguistic templates and that this predictably influences their interpretations of novel NN compounds. She looked to subjects' supposedly context-free interpretations of novel compounds to see how likely they were to choose one of the following strategies for interpretation: linguistic templates; use of real-world knowledge to fill in templates; accommodation; use of an un-filled schema. "Use of real-world knowledge to fill in templates" involves what Ryder calls SEMANTIC INFORMATION SCHEMAS which represent the schematic knowledge prompted by the individual nouns. This strategy is best described by Ryder:

> Having chosen a linguistic template, the listener searches the semantic information schemas connected with each of the element nouns in the compound to find a common schema that can be used to justify and fill in the meaning provided by the template. There may be several such event, entity and feature schemas. In this case, the listener chooses one of them to use in his interpretation, or he may choose more than one of them, if they are mutually compatible. (90)

ACCOMMODATION refers to altering a schema slightly in order for it to make sense. An example Ryder gives is a dog that drinks wine. Accepting this idea entails altering one's encyclopedic knowledge and hence schematic understanding of dogs. The final strategy, "use of an un-filled schema", is when the listener "choose[s] not to fill in the semantic skeleton of the template, and wait for more information, perhaps from context, to help him in choosing the right semantic information" (93).

Ryder ran two experiments in which subjects were required to provide definitions for a series of novel NN compounds. While the data produced is quite interesting, the experiments do not allow us to make many strong conclusions about how people interpret NN compounds. In Ryder's own words, "[i]t is not easy to find unambiguous evidence for

linguistic templates on the level of particular compounds, because use of pragmatics … and use of templates usually produce the same results" (131). The stimulus of the experiments consisted of (presumably) novel NN compounds while the output consisted of people's interpretations of them. It isn't clear what outcome would allow us to conclude that someone is using this or that strategy for interpreting novel compounds. This problem parallels the issue faced by finite relational taxonomies. Just as reducing a compound's meaning to a single abstract relation is problematic, so too might the assumption that an interpretation is motivated by just one strategy.

Subsequent to Ryder's work, Fauconnier's (1994) MENTAL SPACES THEORY and Fauconnier & Turner's (1998, 2002) CONCEPTUAL BLENDING THEORY (CBT) have proven useful in accounting for both linguistic reference and meaning creation in general. Benczes (2006) used the descriptive tools of CBT to account for more than 30 metaphorical and/or metonymical NN compounds. In order to understand her approach a broader understanding of mental spaces and blending is required.

Like CG, mental spaces and conceptual blending theory are motivated by the frame semantics view. Mental spaces are delimited mental representations of referential elements which are constructed on the fly to meet current discourse needs. They are integrated via structural mappings in order to understand incoming language and to create new concepts. Typically, one space provides an organizing structure onto which elements in other mental spaces are mapped. Often, such an organizing structure is a schema representing long term knowledge of some typical event or scenario.

Grammatical constructions are viewed as prompts for setting up mental spaces and creating connections among them. The XYZ construction, instantiated by *Vanity is the*

quicksand of reason for example, is one such construction (Turner 1991; Fauconnier 1994; Fauconnier & Turner 2002). This example prompts us to set up a mental space containing 'vanity' and 'reason' and to then create mappings between elements of that space and elements of our schematic knowledge of QUICKSAND. Thus 'vanity' is analogically connected to 'quicksand' and 'reason' is analogically connected to a 'traveler' who gets caught in it. These links produce a BLENDED SPACE in which 'reason' is destroyed by 'vanity'.

Importantly, the projection of the organizing structure onto the blended space is selective. Not everything we know about quicksand is required to make sense of *Vanity is the quicksand of reason*. Certain elements of this schema will be understood as more relevant than others for structuring our understanding of how vanity and reason can be related. These elements will result in EMERGENT PROPERTIES in the blended space. For instance, we know that people do not deliberately walk into quicksand. This knowledge motivates us to think of vanity as some sort of "trap" which people do not realize they are "walking into". *Vanity is the quicksand of reason* can not only be understood as a statement that vanity destroys one's ability to reason, but also as an admonition that vigilance and selfawareness are required to maintain this ability.

Different aspects of the QUICKSAND schema would be used to structure our understanding of *Balsa wood is the quicksand of building materials*. The XYZ construction again prompts us to set up a schematic space for quicksand and link this to elements in another mental space, which in this example contains 'balsa wood' and 'building materials'. Knowledge that balsa wood is unusually soft and light in relation to other woods motivates analogy between 'building materials' and 'types of ground'. One can then

understand that *Balsa wood is the quicksand of building materials* to be a statement of the similarity between balsa wood and quicksand within their respective domains and their lack of structural integrity. Whether the sentence is taken as a warning to avoid balsa wood depends on the discourse context and one's mental model of others' communicative intentions.

CBT accounts for nonmetaphorical language with the same conceptual structures and mechanisms as it does for the metaphorical and analogical examples discussed above. For example, *Paul is the father of Sally* serves as a prompt to place 'Paul' and 'Sally' together in one mental space and to make the appropriate mappings onto a FAMILY space. Blending theory thus posits a single mechanism for understanding both metaphorical and literal language. It does so in part by positing that language comprehension involves the online creation of schematically organized spaces.

Benczes (2006) demonstrates that CBT has robust application to the semantics of NN compounds by accounting for more than thirty metaphorical and metonymical NN compounds. To illustrate I will briefly discuss her analysis of *jailbird*. For this compound she proposes two input spaces, one for an IMPRISONED PERSON and one for a CAGED BIRD. In the IMPRISONED PERSON space there are the elements 'prisoner' and 'prison-cell'. In the CAGED BIRD space there are 'bird' and 'birdcage'. An analogy line is drawn between 'bird' and 'prisoner' and between 'birdcage' and 'prison cell'. The generic space is structured by what is in common between the two input spaces, namely the idea of something animate being contained in a space and that animate thing desiring to escape such confinement. *Jailbird* prompts us to run this metaphor-based blend through which we conceive of a prisoner as a caged bird. The emotional state of the bird can be projected

from the CAGED BIRD space onto the blended space. We thus are capable of importing the feelings we presume a bird to have when caged and when being released from a cage to respectively understand the feelings of an imprisoned person or a recently released prisoner. Benczes provides many more analyses of this sort, demonstrating the explanatory power that CBT has for the semantics of NN compounds.

As was discussed earlier, most research on NN compounds is either deliberately restricted to or incidentally biased toward compounds featuring two concrete nouns for which there is a literal interpretation. Many compounds may fit that description but a complete account of NN compounds has to be extended to abstract, figurative, and metonymical meanings. Benczes' blending analysis demonstrates that schema-oriented approaches can meet that challenge.

2.2.3 Summary

Schema-based approaches make improvements over the relation listing approaches of generative and descriptive linguists. With the representation of specific structures of concepts, schemas help explain where some of the finer level details of NN compound interpretations come from. The role of schematic information can be expanded beyond schemas corresponding to lexical items to explain how compound interpretation can involve scenario creation and property mapping. As the discussion of CG demonstrates, accounting for NN compounds in terms of schemas helps provide plausible links to general linguistic and conceptual processes. Finally, Benczes' (2006) CBT-based analysis demonstrates that schemas are capable of accounting for compounds with metaphorical and metonymical meanings.

2.3 Opposition to schemas: CARIN and RICE

Two psycholinguistic theories of concept combination, Gagné & Shoben's (1997) COMPETITION AMONG RELATIONS IN NOMINALS (CARIN) and its subsequent refinement by Spalding et al. (2010) and Gagné & Spalding (2013) into RELATIONAL INTERPRETATION COMPETITIVE EVALUATION (RICE), attempt to account for compound comprehension without recourse to schematic representation. These theories rely on categories of THEMATIC RELATIONS more akin to the elements of lists created by earlier descriptive and generative accounts. As their names suggest, they are chiefly concerned with illuminating competitive processes which produce compound interpretations. This section provides an overview of CARIN and RICE and the evidence used to support their claims. It will be argued that these theories lack the empirical grounding and theoretical coherence to provide a serious rejection of schemas and that filling their explanatory gaps is only achieved by turning them into schema-based theories.

2.3.1 Initial evidence and issues

Gagné & Shoben's (1997) CARIN theory claims that people have statistical knowledge of how words are used in nominal compounds and that differences in ease of processing of various compounds reflects this knowledge. Suppose, for example, that a noun, X, is often used as a modifier in compounds whose meanings are characterized by a Locative relation between the two nouns. Suppose also that X rarely occurs as a modifier in compounds whose meaning is characterized by a Topic relation. CARIN would predict easier processing, as indicated by online measures, for novel compounds of the form XY which have a plausible Locative interpretation than for those of the same form which instead have

a more plausible interpretation based on a Topic relation. Though CARIN is presented as a non-schema-based approach to NN compounds, this prediction would be a natural processing consequence of Ryder's (1994) concept of the linguistic template, which was discussed in Section 2.2.2.

Gagné & Shoben conducted three experiments to demonstrate CARIN's predicted relational frequency effect. To do so, they generated a set of combined concepts by randomly pairing 91 nouns and nonpredicating adjectives from Levi's (1978) appendix. For the resulting modifier-noun pairs, they dichotomously decided which ones had sensible literal interpretations, and for the ones that did, categorized their interpretation into a list of relations which was largely motivated by Levi's taxonomy of predicates. This list of relations is found in Table 2.6 with example modifier-noun combinations provided by Gagné & Shoben (where available). As Gagné & Spalding (2009) later explain, this list of relations is not meant to account for all possible compound meanings but was intended as a starting point to operationalize semantic relations in a way that enables the testing of CARIN's predictions.

Based on their categorization for each modifier-noun combination, they calculated a relational frequency for each word in both the modifier and head noun position. To illustrate, the modifier frequency of a word, X, for a particular relation, is the percentage of all combined concepts in which X is the modifier and the relation of interest accounts for the meaning of the combined concept. An analogous head noun relational frequency was also measured for each word. Based on these results, Gagné & Shoben then dichotomously categorized each relation for each word as High or Low frequency in each constituent position. The High/Low dichotomy was then used to construct a list of

modifier-noun pairs which varied the relative relational frequency of each constituent. Items were either HH, HL, or LH, reflecting relations that are high for both constituents, high for just the modifier, or high for just the head noun. LL items were not included.

RELATION	EXAMPLE NOUN-NOUN AND ADJECTIVE-NOUN PAIRS
Noun Causes Modifier	NA
Modifier Causes Noun	*financial headache, tax pressure*
Noun Has Modifier	*coal town, floral property*
Modifier Has Noun	*family cow, plant shape*
Noun Makes Modifier	*musical light, lemon plant*
Noun Made Of Modifier	*cream sauce, wood shavings*
Noun For Modifier	*sugar scales, cooking hole*
Noun Is Modifier	*horse toy, historical members*
Noun Uses Modifier	*industrial forest, steam equipment*
Noun About Modifier	*murder report, juvenile film*
Noun In Modifier	*party dance, urban riots*
Noun Used by Modifier	*moth signals, family utensils*
Modifier In Noun	NA
Noun Derived From Modifier	*grain alcohol, pine dust*
Noun During Modifier	*morning prayers, winter cloud*

Table 2.6 Gagné & Shoben's (1997) taxonomy of thematic relations and examples provided in Appendices.

In Gagné & Shoben's first experiment, participants read a neutral carrier sentence in which the combined concept was the final word. Upon viewing the combined concept, participants indicated with key strokes whether they thought it had a sensible interpretation or not. Mean response times in the HH, HL, and LH conditions were 1027 ms, 1038 ms, and 1068 ms. Interestingly, the LH condition resulted in significantly longer response

times than the HH condition but the HL condition did not. A double lexical decision task on the same items ruled out differences in lexical availability across conditions. Finally, Gagné & Shoben replicated the findings from their first experiment but with the relation types equated across conditions and having participants complete the sense/nonsense task by simply viewing the combined concepts in isolation. A similar pattern emerged as before, with respective mean response times of 1138 ms, 1190 ms, and 1250 ms for the HH, HL, and LH conditions. Gagné & Shoben interpret these results to mean that the relational frequency of the modifier influences the interpretation of compounds but the relational frequency of the head noun does not. Specifically, CARIN states that on the basis of relative relational frequency, the modifier SUGGESTS relations and one of these is then chosen to form the general meaning of the compound. Knowledge about the head noun and general world knowledge are then used to ELABORATE the meaning further.

Though the observed asymmetry between the head noun and the modifier's relational frequency effects is compelling, an alternative explanation is offered by a functional perspective. It is not typical for head nouns to supply relational information. Rather, they often pick out the general category of the thing being referred to. An XY is likely to be an instance of a Y whether X is a noun or an adjective. In other words, the head noun is still "doing" the same thing it usually does. The role of the modifier in a NN compound on the other hand presents more of an open question. A NN compound could either be understood through some relation between the two concepts, or a property of the modifying noun could be mapped onto some aspect of the head noun. One has to decide which function the modifying noun is playing whereas the head noun's function is more stable across contexts. A high relational frequency for the modifier could therefore help disambiguate its role,

reducing the processing cost of using a noun as a modifier. The head noun's relational frequency plays no analogously facilitative role. It is therefore unnecessary to claim that the head noun's relational frequency does not influence the selection of the relation.

Gagné & Shoben rightly point out, however, that their findings are inconsistent with schema modification theory (Murphy 1988, 1990). They argue that because this approach posits that the modifier has to fill a slot in the head noun or create one if it doesn't already exist, that the theory predicts slower times in the HL condition than the HH condition. Additionally, they argue that because schema modification theory posits that the head noun's schema represents highly specific information, the theory cannot explain why such a general level semantic relation was capable of affecting ease of processing.

From here Gagné & Shoben go a step too far and present their relation-based approach as an alternative to schema-based approaches in general. In support for this dichotomy, they point out that a relation that is used to link two nouns is not necessarily a part of either concept. This differs from Murphy's approach because in his schema view, slots are necessarily part of the head noun's schema. Thus Gagné & Shoben state that "[u]nlike dimensions that are necessarily an integral part of the head-noun schema, relations may be separate entities that connect (or bind) one concept (e.g., the modifier) to another (e.g., the head noun)" (72). Here, Gagné & Shoben have created a false dichotomy by taking Murphy's highly specific claims as a stand-in for schema theories in general. In doing so they do not address the general spirit of the theoretical construct of the schema. Rumelhart (1980), for example, makes no reference to slots or fillers and applies the construct to a much greater range phenomena than Murphy does, claiming that schemas actually represent ALL manner of knowledge.

Thus, it would be natural for a schema theory to account for Gagné & Shoben's thematic relations as schemas themselves. For example, their About relation would be understood with a TOPICALITY schema. Not just anything can coherently be said to have a topic. Communicative forms through which information is shared or expressed are the sort of thing that have topics. Therefore, things don't instantiate the category of 'topic' if there is not also something instantiating a communicative 'medium'. 'Topic' and 'medium' are co-dependent within a schema for TOPICALITY. This aspect of schemas, their representation of structured knowledge which includes the typical relations among things in different situations, is more important than the vagaries resulting from a single schema-based theory. It is only by treating Murphy's specific processing assumptions as inherent to schema theories in general that one can make sense of Gagné & Shoben's claim of creating a nonschematic relation-based theory.

This schema- vs relation-based dichotomy motivates the exclusion of schemas from all aspects of compound interpretation in subsequent iterations of CARIN. This approach begs the question of what Gagné & Shoben think relations are and how they could be represented nonschematically. Though they use Levi's (1978) taxonomy as a starting point for their own, they make no overt claims that compound meaning is motivated by a deep structure. It is not clear, therefore, how Gagné & Shoben would explain nonschematic representations of relations.

Given that Gagné & Shoben make no arguments for an underlying sentential representation, it is unclear why their materials include nonpredicating adjectives along with NN compounds. Because they are concerned with online measures, this also raises questions about the reliability of their results. Though any theory should be able to explain

meanings of compounds whose constituents vary grammatically and semantically, such variables should be controlled for in tasks producing online measures. The ease of understanding concept combinations could be influenced by: whether a constituent is a mass or count noun; whether a constituent is a noun or an adjective; whether a constituent is a derived or underived noun; whether a noun is abstract or concrete. Gagné & Shoben provide no controls for such variables.

As review of the examples in Table 2.6 highlights, an additional consequence of using Levi's (1978) taxonomy as a starting point is that Gagné & Shoben inherit some of the same problems common to all taxonomies of relations. Because many compound meanings are characterized by multiple relations, categorization is often arbitrary. *Family cow*, for example, is categorized as 'Modifier Has Noun' when it could just as easily be categorized as 'Noun For Modifier'. The issue of arbitrary categorization is particularly problematic here because Gagné & Shoben's construction of experimental materials relied on such categorization.

Further methodological concerns, which call into question the reliability of their observed asymmetry in relation frequency effects, have been raised by other researchers. Gagné & Shoben's method of dichotomizing constituents as High or Low frequency has been criticized by Wisniewski & Murphy (2005), Murphy & Wisniewski (2006), and Maguire et al. (2007). Gagné & Shoben's relational frequencies were based on the rate at which they themselves used particular relations to interpret random pairings of words. Arbitrary cutoffs were used in assessing whether a particular relation was High or Low frequency for a word. Any relation that accounted for more than 60% of compound meaning types for a given word was labeled High and all others Low. But if no relation

constituted 60% of the compound meanings, relations were added until the 60% threshold was reached. Undesirably, a modifier's five most frequent relations could be 20%, 19%, 18%, 17%, 16%, and this process would determine the first four to be high frequency and the last one to be low frequency even though they all cluster around 18%. It is not clear how this method could reliably capture the statistical knowledge people have of actual language use. Maguire et al. (2007) showed that it in fact does not by applying Gagné and Shoben's taxonomy to a representative sample of compounds from the British National Corpus (Burnard 2000). This process resulted in High/Low categorization that contradicted Gagné & Shoben's nearly half the time.

There are also concerns of inadequate controls for variables that are known to influence ease of processing. Wisniewski & Murphy (2005) obtained measures for familiarity and plausibility for items from Gagné & Shoben's experiments. They found a significant difference in familiarity and plausibility ratings for the LH condition than the HH and HL conditions. But a final and perhaps most important issue with the empirical basis of CARIN is the nature of the sense/nonsense task. This task, in which participants have to dichotomously decide whether a modifier-noun pair has a sensible literal interpretation, has been used in a variety of subsequent studies (Gagné 2000, 2001, 2002; Estes 2003; Gagné et al. 2005a). The validity of these experiments rests on an assumption of the non-ambiguity of the items encountered since each item is assumed to be interpreted with a particular relation. NN compounds, which constitute a majority of items in such experiments, are notable BECAUSE OF their ambiguity. Without robust norming tasks in which it is demonstrated that a given novel NN compound is interpreted the same way

nearly every time, it is not clear what a sense/nonsense task tells us about ease of access or competition among specific semantic relations.

Irrespective of these theoretical and methodological concerns, the exclusion of schemas from CARIN produces a few testable claims about NN compound interpretation: i) all should express a relation between the constituent noun concepts ii) all are motivated by a general relation which is then subsequently refined to a particular interpretation iii) there is competition among discretely contrasting semantic relations. Of these, one and only one is chosen to motivate the interpretation.

Qualitative and experimental evidence reported in Chapters 4 and 5 challenge each of these claims. The third claim produces the same problem that categorization via taxonomy produced for descriptive and generative approaches. How do we avoid arbitrary semantic categorization and where do the specifics of compound interpretation come from? Schemas, even in the relatively rigid schema modification theory, provide at least a partial explanation because they represent detailed structured knowledge of the head noun's concept. The exclusion of schemas makes the specificity of compound interpretations all the more difficult to account for.

2.3.2 Accounting for property-based interpretations

Gagné (2000) clarifies how CARIN explains property-based interpretations. In CARIN, property-based interpretations result from the same sort of processes that produce relation-based interpretations. They reflect meanings that are motivated by a Resembles relation, which is less frequent than other relations and therefore a weak competitor in relation competition. Gagné (2000) claims that results from a sense/nonsense task provide support for this claim. In this task participants took longer to respond to concept combinations

which are presumably understood with a property-based meaning than to those which are presumably understood with a relation-based meaning. This would be predicted because using the Resembles relation to interpret a compound would take longer because relations that are stronger competitors would have to be ruled out. Gagné additionally claims that these results contradict Wisniewski & Love's (1998) claims that relation- and property-based interpretations arise from distinct processes, neither of which are inherently favored. But Gagné seems to confirm the consequent here. Though a theory in which property-based interpretations are attempted only after ruling out higher frequency relations predicts the observed difference in response times, the converse is not necessarily the case. Property-based interpretations could simply be more difficult, owing to the fact that it is noncanonical for a noun to be used to confer a property onto another noun. This could produce Gagné's response time results regardless of whether the two processes occur in parallel or whether one must be chosen as "the strategy" for interpreting a compound.

The bigger problem for CARIN regarding property-based interpretations is the plausibility of the Resembles relation. Gagné justifies this relation by appealing to the fact that previous linguists included it as a relational category. But linguists' descriptive needs are not the same as psychologists' explanatory goals. Gagné provides no account of how CARIN motivates specific property-based interpretations. If they are low frequency, why would a general property-based relation ever be selected, especially if a particular property has to be selected after the general Resembles relation? And if the Resembles relation is selected, on what basis is a property chosen? The lack of clarity here contrasts with Wisniewski & Love's (1998) account which offers a plausible mechanisms of comparing

the structures of the two concepts and mapping a salient property from one onto the other. Notably, such systematic comparison relies on schemas.

2.3.3 Subsequent iterations

Since Gagné & Shoben's (1997) first presentation of CARIN, subsequent experimental findings have been used to support or modify the theory. Gagné (2001) reports more experiments which test the claim that the modifier's relational frequency matters but the head noun's does not. The experiments employ the same sense/nonsense task used by Gagné & Shoben (1997). In one experiment, pairings of prime and target modifier-noun combinations (including nonpredicating adjectives) were created which shared the same head noun and which ostensibly would be interpreted with the same relation. For half the pairs, the target item was HL and for the other half it was HH. Consistent with CARIN's claim that the head noun's relational frequency does not influence processing, the experimental condition did not affect response times. In another experiment, which was identical to the first except that the modifier was repeated and the HL condition was replaced with the LH condition, response times were reliably faster in the HH condition than the LH condition. Though this replicates Gagné & Shoben's (1997) findings, it does so by utilizing many of the same problematic experimental design choices.

Gagné (2002) similarly extends Gagné & Shoben's (1997) findings of asymmetric relational frequency effects beyond lexical items to semantic classes generally. In one experiment, two primes were created for each target modifier-noun combination. Each prime had a head noun that was semantically similar to the target's. For each target, one prime had an intended semantic relation that was different from the target's, and the other shared the same relation as the prime. Participants completed the same sense/nonsense task

as before. The Same/Different relation conditions had no effect on response times. A second experiment was run where the primes and targets had semantically similar modifiers instead of head nouns. Here, the Same relation condition resulted in reliably shorter response times than the Different relation condition did. Gagné concludes that CARIN must be updated to include people's apparent statistical knowledge of how relations pair with semantic categories of constituents. Again, as the discussion of cognitive grammar and Ryder's (1994) work in Section 2.2.2 indicates, semantic frequency effects can also be handled by schema-based approaches.

More substantial changes to CARIN were motivated by Spalding & Gagné's (2007) findings that selectively changing the availability of different properties of a head noun can influence the acceptability of definitions for the compound. In one experiment, a list of modifier-noun combinations was used to construct materials. Most were NN compounds but a few arguably had modifiers that were adjective-like, such as *juvenile*. For each combination a Dominant and a Subdominant interpretation had been determined through a norming task. Two statements were constructed, one which highlighted a feature that was consistent with the Dominant interpretation and one which highlighted a feature that was Neutral toward the two interpretations. To illustrate, the Dominant interpretation of *clay machine* was 'a machine for making clay' while the Subdominant interpretation was 'a machine made of clay'. The Dominant prime was 'some machines are sturdy' while the Neutral prime was 'some machines are expensive'. These two variables were crossed in a 2 × 2 design. For each item, participants first saw one of the statements and selected whether it was true or not, then they saw the modifier-noun combination paired with one of the two definitions and decided whether it was appropriate. Dominant condition

statements resulted in higher acceptability of the Dominant definition. The interaction between Prime and Definition Type was significant. This experiment was repeated but with a statement highlighting a feature of the Subdominant definition instead of the Dominant definition. Returning to the *clay machine* example, the Subdominant statement was 'some machines are fragile'. The results paralleled those of the first experiment. The Subdominant statement condition produced higher rates of the Subdominant interpretation and lower rates of the Dominant interpretation. Again, the predicted interaction was significant.

Spalding & Gagné interpret these results as consistent with Gagné & Shoben's (1997) view that the modifier suggests potential relations and that the head noun evaluates these. Specifically, they claim that the availability of a feature of the head noun, either from long-term knowledge or temporary activation, guides the choice among relations suggested by the modifier. Schemas, when viewed more broadly as the organizing units of the conceptual system, offer another explanation for these results. The primes, such as 'some machines are fragile', did not simply activate a feature of the head noun. Understanding them would involve strengthening or constructing a schema for FRAGILE MACHINES. This schema then becomes highly available and more likely to constrain interpretations of *clay machine*.

Spalding et al. (2010) further clarify why the discrepancies between the results of Gagné & Shoben (1997) and Spalding & Gagné (2007) provide evidence that the head and modifier play distinct roles in compound processing. They claim that Gagné and Shoben's (1997) sense/nonsense task reflects the earlier moments of compound comprehension. This is because subjects simply have to determine categorically if there is a sensible interpretation. They do not have to provide a specific interpretation. Spalding & Gagné's (2007) task, on the other hand, involved verifying features, which they assume to reflect

the evaluation of possible relations. The framework where modifiers suggest relations and head nouns evaluate them is consistent with this view.

Spalding et al. (2010) ran a series of experiments to further develop the suggest-evaluate framework. The first was designed to replicate Gagné & Shoben's (1997) finding of asymmetric relational frequency effects, though in a slightly different design. Here prime/target pairs always included one common constituent. They varied which constituent was shared as well as whether the prime and target shared the same relation, creating a 2 × 2 design. In a sense/nonsense task, Same-relation items were responded to faster than Different-relation items when the modifier was shared but not when the head noun was shared. A subsequent experiment was then run using the same items, but replacing the sense/nonsense task with a relation verification task. For example, the item *knitting blog* was presented as 'knitting blog = blog about knitting'. In this task Same-relation items were responded to more quickly than Different-relation items, and this difference was greater for repeated head nouns than repeated modifiers. A third experiment replicated the second but with a control for repetition of phrasal structure across relation descriptions. Primes were embedded in generic sentences that were consistent with the intended meaning rather than presenting them with relations to be confirmed. Here, the same influence of Relation was observed when the head noun was repeated. In this case, there was no such effect for the modifier. Spalding et al. interpret these results as consistent with the suggest-evaluate framework.

Spalding et al. (2010) and Gagné & Spalding (2013) codify the suggest-evaluate framework into the RICE theory of compound processing. This theory inherits many claims from CARIN. Ambiguity in compounds is resolved via competition among possible

relations. One relation is selected which motivates a general understanding of the compound. The meaning is then elaborated to include details that the general relation cannot provide. As in CARIN, RICE assumes that all compound interpretations and transparent compound meanings are motivated by what could be described as a relation between constituents. Property-based interpretations are still assumed to be motivated by selection of the Resembles relation. The processing of compounds and the competitiveness of particular relations are influenced by distributional knowledge of how nouns are used in compounds. As in CARIN, the effect of this knowledge is not the same for the modifier and the noun.

RICE differs from CARIN in a few key ways. CARIN claims that relational frequency of the head noun does not influence processing whereas RICE claims that it does. The specific influence is woven into RICE's serial processing view. First, the modifier's relational frequency suggests strong relation candidates. Second, statistical and conceptual knowledge of the modifier and head noun are used to evaluate the suggested relations and select one of them. Finally, an elaboration stage takes place in which more specific properties emerge. Gagné & Spalding (2013) emphasize that their 3-stage model is not strictly serial in that the stages probably overlap. This position, however, raises a few questions. What is going on when the suggest and evaluate stages overlap? Does the head noun's relational frequency motivate a loop which can go back to the suggest process to find better candidates from the modifier? If a relation is chosen but fails to be elaborated, how far back can the process go? Does it return to the suggest stage or can it only go back to the evaluate stage?

Gagné & Spalding's (2013) agnosticism toward many aspects of relations undermines the internal validity of the theory. In RICE there is no commitment to a particular list of relations or to relations at a particular level of abstraction. This raises the question of how negative results can be reliably interpreted. If, for example, compounds are understood through more specific relations, then the lack of priming due to coarse-grained semantic frequencies for head nouns says little about the time course of processing. An additional problem is that Gagné & Spalding's agnosticism seems to imply that relations can be arbitrarily specific. But this is exactly the sort of information that schemas capture because they represent people's specific knowledge of the structures of things and events encountered in everyday life. Gagné & Spalding are also noncommittal about whether relations are represented independently from their use in compounds. In doing so, they invoke "structure" and "dependence", which schema theories were devised to handle:

> [A]lthough RICE assumes that access is in some way dependent on the constituents, it makes no claims with respect to the representation of relations themselves. Because relations are inherently parts of other structures, it is not clear whether the relations that are used in relational interpretations require separate representations or whether they are recovered for use from their existence within existing relational interpretations. (109)

If RICE was committed to only very abstract relations, there might be room for this stance. But Gagné & Spalding make it clear that RICE views relations as hierarchically embedded, with some being specific versions of broader ones. This means that we have knowledge of specific schemas like CONTAINMENT and PROXIMITY. These relations clearly exist independently of compound interpretations since we use them to reason about our surroundings in nonverbal contexts. By referring to relations as "parts of other structures", Gagné & Spalding demonstrate the difficulty of maintaining the schema vs relation dichotomy. What after all are these nonschematic structures?

RICE's paradoxical stance on relations and schemas results in a few predictions, the testing of which can be used to assess the plausibility of excluding schemas from a theory of compound comprehension. According to RICE all compound interpretations and transparent compound meanings arise from the selection of a single relation between two constituents. In RICE there is no room for higher level conceptual schemas to motivate compound interpretations since it is in theory nonschematic. In RICE, compound meanings and interpretations are motivated by a general level relation and then subsequently elaborated. Any compound whose meaning seems dependent on or motivated by highly specific schematic information would be difficult to explain. These issues motivate the qualitative and experimental research presented in Chapters 4 and 5.

2.3.4 Summary

The CARIN and RICE theories of concept combination attempt to account for NN compound meaning without recourse to schematic representations. In so doing, they are reliant on relations in a way that produces many of the same problems encountered by taxonomic approaches. Though they may account for general aspects of compound meaning, such coarse-grained analysis involves the arbitrary selection of one relation over another. Along with the design issues discussed in Section 2.3.1, this raises questions about the empirical basis for the claim that distributional knowledge of constituents produces an asymmetric influence on processing. Even if such asymmetry were convincingly demonstrated, it would not be a problem for schema theory broadly. It more specifically poses a challenge to theories of language comprehension, such as schema modification theory, which arbitrarily restrict the role of schemas to representing head noun concepts as lists of slots and fillers.

The nearly exclusive reliance on online measures provides little direct evidence for the processes that lead to specific interpretations of novel compounds. From the purported asymmetry in the effect of the modifier versus the head noun's relational frequency it is then a theoretical leap of faith to RICE's formal model of processing stages. CARIN and RICE claim that the modifier's relational frequency suggests relations, one of which forms the basis of the compound's meaning. As Murphy and Wisniewski (2006) point out, it is not clear from this process why a compound would ever be interpreted with a low frequency relation.

The exclusion of schemas further limits CARIN and RICE's explanatory power. While the augmented schema approach provides a plausible explanation for how property-based interpretations arise from comparing structures between constituents in a compound, CARIN and RICE claim that all property-based interpretations arise from selection of a general Resembles relation. It is not clear on what basis one would select the Resembles relation without knowing that there was a specific property which could sensibly be mapped onto the head noun. While schema approaches can account for at least some level of specificity of an interpretation because specific relational knowledge is stored in schemas, CARIN and RICE claim that a gist meaning is supplied by a relation and that that meaning is then somehow elaborated. By Gagné & Spalding's (2013) own admission, this part of their theory is "underdeveloped". This lack of clarity is quite possibly due to the fact that much of the world knowledge that could inform elaboration consists of structured knowledge of events and situations.

2.4 Chapter summary

Early accounts of NN compounds attempted to categorize the types of semantic relations that compounds encompass. Finite taxonomies produced vague categories which did not enable principled categorization of compound meaning. Schemas offer a promising way to avoid the shortcomings of vague relational categories, plausibly accounting for specific aspects of compound meaning, property-based interpretations, and exocentric compounds. Relation-based theories which reject schemas are unclear as to what relations are and reproduce the same problems as vague taxonomies. Given the descriptive fact that NN compound meanings are often relational in nature, the question of whether relations are involved in compound comprehension is not up for debate. The more appropriate question is how such relations and other knowledge are represented and what mechanisms act on that knowledge to enable people to comprehend novel NN compounds. But as the experimental work discussed in this chapter demonstrates, the link between interpretation types and the mechanisms or strategies that produce them is far from straightforward.

On explanatory grounds schema-based approaches have a clear advantage. However, the relative viability of schema and nonschema approaches can be tested further because a nonschematic relation-based view imposes constraints on NN compound meaning which schema-based views do not. Namely, CARIN and RICE predict that transparent NN compound meanings and interpretations of novel NN compounds are motivated by one and only one relation between the two nouns. Among other things, this implies that the meaning cannot be motivated by a relation of each noun to some other situation. The motivating relation must also be at a general enough of a level to provide a gist interpretation which is then elaborated. If the specifics of a compound's meaning seem motivated by highly specific relational knowledge, this view is hard to defend. These contrastive predictions

will be tested against naturally occurring compounds and experimental evidence in Chapters 4 and 5 respectively.

Chapter 3

The theoretical and explanatory breadth of schemas

In accounting for NN compounds, there is a risk of overfitting a theory to the idiosyncrasies of compounds, resulting in a lack of generalizability. Ideally, a framework that can make sense of NN compound meaning should also account for aspects of linguistic meaning, language comprehension, grammatical form, and the social motivations of language use outside of any compound context. If not, it should at least be demonstrated that the assumptions of the theory are consistent with theories that do. This chapter demonstrates that schemas do in fact have broad applicability to language, mind, and the social context of language.

First, a review of a wide variety of observations from social, descriptive, and psychological approaches to language will demonstrate that consistency with schemas is a necessary component of any realistic account of NN compounds. It will then be demonstrated that a schema-based framework can be developed which coherently integrates these observations with claims about NN compound comprehension. This is accomplished by developing a view of schemas that is HUMAN-CENTERED, a term I borrow from the design world (for a general discussion of human-centered design, see Norman 2013). A human-centered approach emphasizes both social and cognitive plausibility, enabling us to account for NN compounds within a broader view of language and cognition.

By showing that schemas are the theoretical glue which link research findings on categorization, language comprehension, grammatical theory, and social context, we provide a strong argument for the generalizability of schema-based accounts of NN compounds.

One of the benefits of taking a human-centered approach is that it helps us avoid what could be called "object-oriented theorizing". By treating language and meaning as an "object" of investigation, we often talk about the meaning a word "has" or the meaning "produced" by the creation of a compound. It is as though the constituents were chemicals and the resulting meaning something deterministically yielded through a bonding process. As an unintended consequence, the human beings who create and understand language are taken off stage along with their communicative concerns. In a similar spirit, I point out opportunities for moving beyond the mind as computer metaphor. Though sometimes useful, this metaphor is limited in its ability to explain communicative motivations and real world inferences. Given that reality is not composed of objectively measurable discrete units, overreliance on computational thinking limits the sorts of communicative phenomena that can be explained. The goal of this chapter is thus to put humans front and center in a schema view which makes clear predictions which can be tested against both experimental and corpus data.

By connecting a wide variety of phenomena, the human-centered schema view makes a nonarbitrary appeal to our perception of structure. Without hesitation, people refer to the "structure" of phenomena as varied as buildings, songs, trips, ideas, theories, experiences, and so on. We seem to perceive structure everywhere. Any plausible schema-based account of NN compounds should therefore do much more than describe the structure of noun

concepts. It should also account for the different types of structured knowledge we gain through experience and the ways these different schemas are embedded in and associated with each other.

In this chapter I lay out the general social and cognitive motivations of schemas and describe other insights from socially and cognitively oriented research that must be integrated into a human-centered approach. I then describe in more detail what schemas are and how the human-centered schema approach accounts for NN compounds.

3.1 Toward social adequacy

This section reviews some of the insights from socially oriented language research that lay the groundwork for the human-centered schema view. These are the sorts of insights that must be understood and incorporated into any theory of NN compounds that is consistent with the social reality of language.

3.1.1 Dialogic reality of language

The usage-based perspective I assume in the human-centered schema view is influenced heavily by Volosinov (1973) and Bakhtin (1986). Writing in the early 20th century, they share a framework which criticizes the context-free analysis of language as an abstract object. Volosinov describes this static view as MONOLOGIC and claims that it is a carryover from the philologist's study of texts of dead languages. He offers instead, a view of language as "a continuous chain of speech performances" (72). Each utterance, whether a single spoken word or a written work, is a link in this chain. The use of a word, phrase, or syntactic structure in a particular context, is meaningful because of people's knowledge of

its use in other contexts. Its use invokes not just the intended referential meaning but the affective and situational contexts of its prior use. It is in this way that Volosinov claims that every utterance "makes response to something and is calculated to be responded to in turn" (72). The view of language as continually changing and emerging through a series of utterances and responses (mental or verbal) motivates Bakhtin's use of the term DIALOGIC to describe his and Volosinov's shared understanding of language.

As its name suggests, the dialogic view also emphasizes that utterances occur in specific discursive contexts. That is to say that language is always produced by a speaker or author and always shaped for some addressee. Bakhtin argues that because such ADDRESSIVITY motivates what is said and why, that the real unit of language is the utterance and not the word, phrase or sentence. He humorously demonstrates the inability of an isolated sentence to capture the communicative force of an utterance produced within a particular context:

> The speaker sees that the grass is green and announces: "The grass is green." Such senseless "communications" are often directly regarded as classic examples of the sentence. But in reality any communication like that, addressed to someone or evoking something, has a particular purpose, that is, it is a real link in the chain of speech communion in a particular sphere of human activity or everyday life. (83)

Making a statement of fact is not a goal, but a means to a social end. Understanding the referential meaning of words and phrases serves the communicative goal of understanding the intended meaning, or "point", of an utterance. Restricting investigations into meaning to referential meaning at the sentence level would preclude us from understanding how referential meaning and intended meaning interact.

Consider *The grass is green* in multiple hypothetical contexts. If spoken between friends shortly after the arrival of rain during a ten-year drought, the noteworthiness of the

fact expressed is obvious. To say "the grass is green" is to point out that the recent rains are having a noticeable effect on plant life and that maybe the drought is subsiding. Imagine another situation where someone is debating whether a shirt is blue or green and is looking for things that are blue or green in order to contrast it with. If a friend helpfully says "the grass is green", they are not trying to INFORM them that grass is green. Rather, uttering this sentence would clearly be intended as a suggestion to use the grass as a point of comparison for understanding the ambiguous shirt's color. The communicative impact of *The grass is green* depends on the interlocutors and their immediate concerns.

3.1.2 Linguistic norms among other norms

Volosinov (1973) states that linguistic norms are no different from other norms of human behavior such as art, fashion, and interaction in general. They are all continually emerging and meaningful in terms of their resonance with prior experience. From the human-centered schema view, this means that schemas of various kinds are emergent and interact with each other. Language schemas can't be separated from SOCIAL SCRIPTS (Schank & Abelson 1977) without losing explanatory power. Being a competent user of a language and member of a community requires knowledge of various types of schemas, though three in particular stand out: i) schemas of reference, which represent how words and phrases can be used to prompt for referential meanings in interlocutors' minds ii) social scripts, which represent various social situations and the roles played therein iii) schemas in between, which represent how different linguistic resources can be used to play out social roles.

Understanding the systematicity in this in-between space is one of the main goals of Hymes' (1962) ETHNOGRAPHY OF SPEAKING. Highlighting that linguistic knowledge alone

is not sufficient for successful communication in different speech events, he notes that misunderstandings often arise when "the referential value of a message is understood, but not the expressive or directive import, because the Receiver does not share the Sender's conventional understandings, or code, for these" (37). When is it appropriate to make a statement of fact? When is it appropriate to ask personal questions? When is it appropriate to ask for someone's help? And what does it mean interactionally to do any of these things? The answers to these questions depend on social scripts, which are culturally mediated and intersubjectively negotiated. In fact, even this is a simplification. Utterances help negotiate, verify, and shape social scripts just as much as social scripts are used to guide choices in speech events.

Gumperz' (1993) work on interethnic communication further demonstrates the degree to which successful language use relies on general sociocultural knowledge. In one study he describes an interaction between "Don", an Indian immigrant in Britain, and "Liz" an instructor who is offering a course on interethnic communication. Don is interested in her course but Liz suggests that it might not be a good fit given the course he is currently enrolled in. They meet to discuss the issue, and throughout their conversation, there is a great deal of misunderstanding. One of the main sources of tension is Don's repeated claims that Liz plays a role in determining who takes the course. Liz explains that she has no part in the admissions process and says that he is intentionally contradicting her. Nevertheless, Don continues to state that she plays a role in determining admissions.

Having analyzed this conversation in collaboration with Indian-English speaking colleagues, Gumperz reports that "an Indian-English speaker would interpret Don's action not as contradicting Liz but as an instance of a kind of pleading which is typical of

situations of this kind where a member of the lay public makes a request of a representative of a public institution" (1993: 205). He further explains that "laypersons represent themselves as victims of circumstances" while depicting the official as "all-powerful and in control, thus able to assist in finding a solution to the problem" (206). Though Don and Liz both understand their context to be bureaucratic, part of their misunderstanding stems from using different social schemas to model the interaction, its purpose, their respective roles, and how language is used to achieve those goals. In a socially and psychologically meaningful sense, Don and Liz don't know who each other are because they are working from different scripts. This makes it quite difficult for them to come to a common understanding of a variety of utterances within their interaction.

3.1.3 A sociocognitive view of context

Gumperz' observations are echoed in some of van Dijk's (2008) insights on context. Just as we lose a lot by restricting linguistic analysis to the out-of-context sentence, context cannot be productively reduced to a set of objective facts about a speech event's surrounding environment. Language users rely on mental representations of general social scripts and culturally mediated knowledge of appropriate use of language in a variety of situations. In the example above, Don and Liz's communication problems stem from their using different CONTEXT MODELS (van Dijk 2008). Though intersubjectively negotiated, context models emerge from one's personal history of experiences.

Van Dijk also emphasizes that the surrounding facts of a communicative situation which interlocutors are aware of do not have equal influence on what is said and how it is understood. The ubiquitous but informal appeal to context in language research seems motivated by the fact that certain elements of a surrounding situation are particularly

relevant while others are not. It is these relevant facts of the situation, as represented in interlocutors' mental models, that we meaningfully refer to as "the context" of an utterance. Take again the example of *The grass is green* when uttered during a drought. If one of the hypothetical interlocutors says this in the midst of a discussion of whether to sit inside or outside at a restaurant, it could be interpreted as a suggestion of sitting outside in order to enjoy the natural beauty. Despite the fact that it is no more or less true that there is an ongoing drought, this fact likely has no relevance for comprehending the intended meaning of *The grass is green* uttered within such a restaurant context. This highlights the distinction between world knowledge and context. Some but not all of the factual information that is said to be world knowledge is capable of entering into a communicative context. Understanding *The grass is green* as meaningful with respect to an ongoing drought requires other world knowledge, such as the fact that water makes plants grow and thrive. This fact about plant life does not produce a "context effect" but is a necessary component of making sense of the interlocutor's statement. Similarly, *The grass is green* could be said between the same interlocutors either immediately after a drought or many years after a drought. In both cases, the interlocutors could have equal knowledge of the fact that there was a drought spanning a particular range of years. But it might only be perceived as relevant in one of those situations.

Another crucial part of people's representation of context is their representation of other people's knowledge. Van Dijk posits that we rely on a K-DEVICE which monitors and constantly updates a mental model of other people's knowledge. This accounts for what has traditionally been called COMMON GROUND in discourse while also providing a source of information for reading other people's intentions. The relevance of having a mental

model of other people's knowledge is artfully illustrated by Tomasello's (2008) discussion of the different meanings that a simple act of pointing can convey. He gives an example of being outside of a library with a friend and pointing to some bikes. If he knows that his friend had just had a nasty break-up and they both recognize one of the bikes to be the ex-boyfriend's, then the gesture can be interpreted as an indication of the fact that he is probably nearby, and that maybe they should leave. The act of pointing would be interpreted differently if it was known that the bike he points to was his interlocutor's which had recently been stolen. Likewise, if they had been wondering whether the library was open, pointing out the bikes calls attention to evidence that it is indeed open. These examples demonstrate how different shared knowledge produces different contexts in otherwise identical physical situations. Tomasello argues that mind reading has relevance beyond establishing the common ground and exhibits a degree of recursivity. That is to say, for the entire communicative event to take place, the person doing the pointing assumes that their communicative partner assumes that they are trying to be informative, helpful, and cooperative. The specific inferences about the intended meaning of the pointing gesture rely on application of Gricean (1975) maxims to recursively embedded mental models of mental models.

3.1.4 Summary

The dialogic view of language provides a coherent usage-based perspective through which we understand that conventionalized lexical meaning is an abstraction from situated communicative events. Reference is something people do and this activity is made possible by the construction of reference schemas. These schemas represent knowledge of how phonological and syntactic forms have been used to establish common ground and to refer

to its component parts. The construction and implementation of such schemas is made possible in part by people's attempts to read each other's minds and attend to interlocutors' intended meanings. Understanding intentions cannot be done without reliance on culturally mediated scripts which provide information about what types of social situations are common and what types of roles are ascribed to participants within those scripts. This general knowledge can interact with specific knowledge of interlocutors' personal histories to produce effects of addressivity at varying levels of detail. Language is produced by a particular speaker or writer for a particular audience, whether that is a specific person or a general group of people. Knowledge of who is producing language and who it is for facilitates understanding the point of an utterance. Thus context includes not only who the participants are, but the participants' schematic mental representations of who they think they are and how this fits in with culturally conventionalized behavior. It is through experience that one learns what sorts of things are relevant and appropriate to different communicative situations. In sum, we have a complex network of schemas for reference, social situations, and communicative context, through which word meaning is learned, social identity is constructed, and utterance meaning is inferred.

3.2 Cognitive motivations

This section reviews findings from cognitive science and cognitive linguistics which motivate a schema-based view of language. Many of these findings stand in contrast with the view from formal semantics, in which grammar and meaning are independent. In the independence view, sentence meaning is a product of the meanings of words and syntactic operations on those words. Operating as a computer, the mind is assumed to store meanings

of words as lists of binary features (+ or - TALL, + or - OLD). Category membership and the veracity of clauses are formally computed in a set theoretic manner. As we will see, there are reasons to doubt this traditional view and schemas often pick up the explanatory slack. Addressing the cognitive realism of schemas enables us to understand language in human-centered rather than computational terms.

3.2.1 The inadequacy of set theory

The computational view of meaning's reliance on truth conditions predicts dichotomous category membership. There are, however, theoretical and experimental reasons to believe that categories are represented probabilistically. Wittgenstein's (1953) theory of FAMILY RESEMBLANCE holds that members of a category do not necessarily share a certain feature. Rather there is a constellation of features which are common among the members and which relate them to each other in a way we perceive as a category, much how the members of a family might tend to have dark hair or big ears or pointy noses. Of the features strongly associated with a category, it's possible that none are shared by all members, like physical traits for family members. Rosh (1975) provides experimental evidence for this fuzzier view of categorization. Participants were asked to rate on a scale from 1 to 7 how well items exemplified a category. The wide range of scores supports a gradient view of categories in which members vary in their degree of fit. Rosch took these findings to mean that categories are organized around PROTOTYPES and that the boundaries of a category are fuzzy. Prototypical members exhibit more of the properties associated with the category while peripheral members exhibit fewer. The likelihood of a newly encountered thing being perceived as member of a category relates to the amount that it exhibits properties which are diagnostic of the prototype.

In addition to prototype effects and family resemblance, another challenge to the idea that category membership is determined by feature-based necessary and sufficient conditions was made by the idea of affordances (Gibson 1977). An affordance is the potential action that an organism can perform with respect to a particular object. An often cited example is that of door knobs and twisting. One could say either that twisting is an affordance of door knobs or that door knobs afford twisting. Notice that twisting is not a feature door knobs HAVE. It is an action that an organism (typically human) is capable of performing on the object. In addition to making binary features problematic, affordances suggest that part of our schematic representation of things includes the event schemas they occur in and the motor procedures required to perform the actions therein. This view is fundamentally human-centered and not computational.

3.2.2 Event-based categorization

Experimental evidence for the psychological reality of schemas and their effect on lexical choice was provided by Labov (1973). In a series of experiments, he presented subjects with depictions of pottery objects varying in width, height, and whether or not they had handles. He additionally varied whether they were empty or filled with something like potatoes, coffee, or flowers. The question was whether subjects would call the objects a "mug", a "bowl", or a "vase" and how much the rates of naming depended on features of the object vs the content within. The objective features and the content variables interacted in a way that suggests people make probabilistic categorization judgments based on their knowledge of events, actions, and features typically associated with such objects. For example, all objective features being equal, if an item contained coffee it was more likely to be called a "mug". The results validate the idea that not only do categories exhibit

prototype effects but so do the schemas in which they participate. Our lexical choices and category judgments for things are based not only on probabilistic knowledge of their structure, but also on probabilistic knowledge of the structure of events in which they take place.

3.2.3 Metaphors

Lakoff & Johnson (1980) lay out a theory of CONCEPTUAL METAPHOR. In this view, metaphor is not just a matter of word meaning but is a cognitive phenomenon in which one domain holistically structures our reasoning about another. For example, one would predict and interpret behavior between romantic partners quite differently if relying on the metaphor LOVE is a BATTLEFIELD versus LOVE is a COLLABORATIVE WORK OF ART. Using the former, we expect lovers to be stressed and perpetually on high alert for potential threats. Using the latter, we understand that the quality of a relationship depends on the chemistry between the two "artists" and that the end result is something greater than either could create on their own. Lakoff & Johnson also point out that the target domain is typically less concrete than the source domain. That is to say we use more concrete domains, such as SPACE, to reason about more abstract domains, such as TIME. Though they rely exclusively on linguistic data and much of that consists of sentences they invented, they offer an abundance of tantalizing evidence suggesting that metaphor is a psychologically real process in which cognitive structures from one domain are used to reason about another. If true, this would suggest a more EMBODIED view of cognition in which reasoning about abstract concepts is parasitic on cognitive systems that allow us to navigate the physical world.

3.2.4 Evidence for embodiment

Boroditsky & Ramscar (2002) provide support for conceptual metaphor through a number of experiments in which physical activities influenced the interpretation of an ambiguous phrase. Experiments were designed based on the analysis of spatial metaphors for time in which points in time are viewed as points in space that extend out before and behind us. These metaphors can be interpreted from an ego-moving perspective or a time-moving perspective. In the ego-moving perspective, people are understood to move through time and thus points in the future are ahead (of us) and points in the past are behind (us). The time-moving perspective sees the points in time as moving toward us and thus future events can be understood as behind (some given point in time) and past events are understood as ahead (of some given point in time). Depending on which perspective is taken, the following language is likely to be interpreted in one of two ways: *Next Wednesday's meeting has been moved ahead two days. What day is the meeting now that it has been rescheduled?*. From the ego-moving perspective, the answer is Friday. From the time-moving perspective it is Monday.

To show that this metaphor analysis has a psychological basis, subjects were primed by either being asked to role across the room in a rolling desk chair or to pull a rolling chair toward them with a rope. Subjects who had moved across the room were more likely to provide answers consistent with the ego-moving perspective than were subjects who had pulled a chair toward themselves. These findings were then replicated in various real-world contexts. In a lunch line, those toward the front were more likely to answer the question from the ego-moving perspective, presumably because they have a greater sense of moving than those at the back of the line. At an airport, those who had just flown were more likely

to answer the question with the ego-moving perspective than those who were picking someone up. In a similar vein, Wilson & Gibbs (2007) facilitated comprehension of metaphorical phrases like *grasp a concept* by having people perform the actions on which the metaphors are based. Those who performed actions that matched the action in the metaphor read the corresponding phrase faster than those who did not. Wilson & Gibbs successfully extended these findings to imagined movements by having subjects think about a variety of matching and nonmatching actions before comprehension tasks. Merely thinking about the action that structures the metaphor facilitated comprehension.

From the outset, the computational view of language processing could not handle these metaphorical understandings and so an assumption emerged that literal interpretations are computed first and then figurative ones are considered. But Gibbs (1979, 1983) found no evidence in reading times that literal meanings have to be computed when figurative meanings are clearly intended. Furthermore, Coulson & Matlock (2001) question the hard dichotomy of literal vs figurative meaning, pointing out that a gradience of N400 measures are prompted by target words corresponding to literal and figurative meanings in ERP studies. This gradience points to literal versus figurative meaning being more of a matter of degree, which is a huge challenge for models of language processing that presuppose discrete stages for each interpretation type.

Research supporting the embodied view of mind rejects the dichotomies assumed by a computational view of language while motivating the claim that schemas are structured in part by associations with perceptual-motor experience.

3.2.5 Simulation and situation models

While researchers in experimental semantics provided evidence for metaphor as a psychologically active process, a compatible embodied view of concepts was proposed by Barsalou (1999a) called PERCEPTUAL SYMBOL SYSTEMS. The theory of perceptual symbol systems expressly rejects the assumption of algorithmic computational approaches to language that concepts have AMODAL representations. Amodal representations of concepts are divorced from the perceptual mechanisms that are used in the experience of a thing or concept. Understanding the word *chair* for example should not activate the motor and perceptual systems involved in sitting in chairs. Modal representations, on the other hand, rely on the sensorimotor, haptic, and socio-emotional processes involved in instances of a concept in everyday life. In language comprehension, episodic memory and knowledge of the typical situations that co-occur with concepts are drawn upon to simulate a scenario to which the incoming language corresponds. Thus Barsalou argues that language is understood more through a SIMULATOR than through a COMPREHENDER. He speculates for example, that hearing a sentence about putting a pencil in a cup prompts the hearer to imagine a pencil vertically oriented while hearing a sentence about putting a pencil on a table does not. This general hypothesis was validated by Stanfield & Zwaan (2001) who created a task where subjects first read a sentence and then decide whether a picture corresponds to the situation described. The pictures varied by 90 degrees of orientation to create images that were either a match or a mismatch with the orientation that a simulation of the sentence would rely upon. Response times were significantly faster for the match condition than the mismatch condition. Numerous experiments have extended these findings and provided evidence for other aspects of situated simulation. For a detailed discussion, see Bergen (2012).

The work on embodied simulation provides evidence that situation models (Zwaan & Radvansky 1998; Zwaan 1999) are based on analog representations of concepts and motivated heavily by real world knowledge. Isberner & Richter (2013), Staub et al. (2007), and Matsuki et al. (2011) have provided additional evidence that the monitoring of event-based plausibility happens NONSTRATEGICALLY. That is to say that incoming information is continually integrated into a developing mental model of the situation being described and that the concern with plausibility is not something people can turn off. As Bergen (2012) says, language users simulate "early and often".

The growing body of evidence for embodied thought and comprehension as simulation challenges the notion that concepts and the meanings of words are stored propositionally and that the meanings of sentences are a mere result of the truth conditions of component structures. Furthermore, schemas explain our ability to fill in information in simulation that is not explicitly stated. Subjects who read sentences about putting a pencil in a cup or on a table were guided by their knowledge that cups are typically vertically oriented, that pencils are often put in cups in this vertical orientation, and that if a cup was on its side, it wouldn't help keep the workspace tidy. It isn't random that subjects preferred a simulation with vertical orientation in that example. It supports the idea that comprehension relies on knowledge of the typical structure of things, events, and situations as well as the human motivations and intentions which produce those patterns.

3.2.6 Good enough processing

Further evidence supporting the noncomputational view of the mind has come from research on GOOD ENOUGH PROCESSING (Ferreira et al. 2002; Ferreira 2003; Ferreira & Patson 2007). The idea behind good enough processing is that the traditional view of

comprehension as guided by a precise algorithmically determined syntactic parser is wrong because it cannot account for the various ways that people have been shown to overlook anomalous and implausible sentences. People bring to the task of understanding language vast knowledge of what sorts of things happen in the world, and most of the language that people encounter is in fact mundane and "normal". Thus Ferreira (2003) reports that accuracy decreases and response times increase when people are asked basic content questions about passive sentences versus their active sentence counterparts. This effect is particularly strong when subjects read implausible sentences such as *The man bit the dog / The dog was bitten by the man*. In the Passive and Implausible conditions, subjects answered correctly who did the action only 74% of the time while in the Active and Implausible conditions they answered this question correctly 99% of the time. This suggests that the coarser grained knowledge that Agents are typically mentioned before Patients affects people's ability to accurately comprehend sentences like *The dog was bitten by the man*. Knowledge of the usual ordering of Agents and Patients constitutes its own schema. We of course additionally have more specific knowledge of how grammatical schemas code for semantic roles (subjects tend to be Agents in active sentences and tend to be more Patient-like in passive sentences). However, in this example, many subjects apparently relied on statistical knowledge that Agents usually come first and that dogs are typically the Agents in dog-human-biting scenarios. Coming to the correct understanding of the sentence would involve acknowledging noncanonical instantiations of two schemas, hence the lower rate of correct responses. In short, a model of language comprehension as a mathematically precise process gives little room for fallibility while schemas account for these types of errors.

3.2.7 Cognitive grammar and the co-dependence of form and function

In cognitive grammar (Langacker 2008), as in other constructional approaches, language is structured by form-meaning pairings and therefore the independence of form and function assumed by Chomsky (1957) is rejected. One advantage of this approach is that it provides an explanation for our ability to produce and understand grammatically noncanonical sentences. Langacker provides the example *After a cat got in the way of our SUV, there was cat all over the driveway*. Rather than dub this sentence ungrammatical, we view *there was cat* as an instantiation of Existential + Singular Noun which we know through experience to correlate with mass noun construal. Along with the suggestion that the cat got run over, the syntactic form guides us to an understanding of *cat* in a mass noun sense. If considered in isolation, *there was cat* might receive a star in traditional dichotomous grammaticality judgments. This example shows, however, that the appropriateness of linguistic form is not independent of meaning. It does not imply, however, that form and meaning do not dissociate. In CG, grammatical rules emerge through the abduction of abstract schemas. These schemas instantiate each other at various levels of specificity. *The old man* is an instance of a noun phrase generally, while at a more specific level it instantiates the syntactic form of Determiner + Adjective + Noun. Our knowledge of the constructions that *old* and *man* are used in enables us to identify them as adjectives and nouns respectively. This of course mirrors the previous discussion of how categorization of physical things depends on the events and situations they typically participate in. Thus grammaticality of a phrase, like other categories, is seen as a matter of degree and is based on how much the phrase conforms to previously abstracted constructional schemas.

3.2.8 Mental spaces, blending, and referential ambiguity

The support for mental spaces and blending similarly comes from its ability to make sense of sentences that pose a much greater challenge for algorithmic views of language. In addition to the metaphorical examples discussed in Section 2.2.2 such as *Vanity is the quicksand of reason*, mental spaces account for our ability to distinguish between references to role and references to identity. An illustrative example from Fauconnier (1994) is *The president changes every seven years*. If we link *the president* to the identity of Francois Mitterand, we have a very silly reading where he experiences emotional or physical development (only?) every seven years. Fauconnier points out that this absurd reading is what a set theoretic model of reference would produce. If, however, we take *the president* as a prompt to set up a mental space with the generic schema of PRESIDENT, we understand that a new person becomes president every seven years. It is difficult to imagine how we could refer to *the president* abstractly as a role without relying on schemas.

The distinction between generic mental spaces with roles and specific mental spaces with identity values for those roles allows us to represent the meanings of ambiguous examples such as *The winner is blonde, but George thinks she's a redhead* (Fauconnier 1994). Does George know who the winner is but mistakenly perceive her hair to be red or is he confused about who the winner is? Either interpretation requires building two mental spaces: a REALITY space for the first clause and a BELIEF space for George corresponding to the second. In the REALITY space, the role of 'winner' is linked to an individual who is blonde. In the BELIEF space, the role of 'winner' is linked to an individual who has red hair. Our interpretation of the sentence depends on how the spaces are linked. If we think George is mistaken about who the winner is, the individual with red

hair in the BELIEF space is linked to the 'winner' role in the REALITY space. If we understand George to be mistaken about the color of the winner's hair, the individual with red hair in the BELIEF space is linked to the individual with blonde hair in the REALITY space.

Because mental spaces can be constructed, embedded, and linked recursively on the fly, they have the potential to model not just the meanings of clauses and sentences but of discourse generally. That is to say, they provide a means of understanding how referential meaning and models of interlocutors' minds are schematically structured and linked. Mental spaces theory gets us a step closer to a socially adequate view of language because interlocutors' mental models of mental models are a part of the context of an utterance. Conveniently, mental spaces theory also dovetails with CG in that it views words and constructions as SPACE BUILDERS, much in the way that CG views words and constructions as prompts for meaning construction.

3.2.9 Summary

Discarding the mind as computer metaphor enables us to better account for categorization as well as a number of linguistic phenomena. Categorization is at least partly motivated by statistical knowledge of the situations in which things participate, the features those things commonly share and how they are interrelated. This view of schemas as a probabilistic representation of structure learned through experience provides insights on metaphor, embodied cognition, the role of mental models in language comprehension, and errors in language comprehension. Through cognitive grammar, Langacker (2008) has demonstrated that maximal application of experientially motivated schemas can produce a coherent view of meaning and linguistic structure. This approach accounts both for the

ways that form and meaning dissociate and the ways they are connected. Finally, mental spaces and conceptual blending can account for both literal and figurative language. They also demonstrate that holistic representations of situations and mappings across them can account for ambiguous cases of co-reference. This cognitively emergent view of schemas is consistent with the dialogic view of language as a continual response to prior language experience. It also has social plausibility in that it enables the flexibility required for reasoning about new and emerging social contexts. Clearly, people are capable of perceiving structure in things and situations. Taking this capacity as a fundamental component of thought and language, we can construct a human-centered view of schemas which enables us to account for much more than the idiosyncrasies of compound meaning.

3.3 The human-centered schema view

This section integrates the observations about what a socially and cognitively adequate view of schemas looks like. I describe in more detail what schemas are, how they are interconnected, and how they enable complex interactions between social and linguistic knowledge. Finally, I discuss how they handle NN compounds.

3.3.1 What schemas are

Because the human-centered view of schemas appeals to our ability to perceive structure in a nonarbitrary way, a wide variety of mental categories and concepts are viewed schematically. It would be impossible and of little value to attempt to list all types of schemas (much like the futility of listing semantic relations in NN compounds). Instead, I

focus on a few qualitatively different types of schemas in order to characterize their emergent, probabilistic, dynamic, and interconnected nature.

Though the human-centered approach holds that most schemas emerge through experience, there is clear variation in their degree of biological vs cultural motivation. Our conceptual system includes a prolific set of dualistically structured perceptual schemas such as HOT-COLD, BIG-SMALL, BRIGHT-DARK, ROUGH-SMOOTH, HARD-SOFT, NARROW-WIDE, LOUD-SOFT, etc. One could argue that schemas are not needed for such perception, that one simply perceives a thing as big or not, or hot or not. But this merely proves the point by creating yet another dualistic structure with which we categorize our experience. Thus at even the most data driven level, experience is structured by a variety of Opposition relations. The human-centered view makes no strong claims about conceptual primitives, but there is a compelling case for dualism as the innate capacity on which the conceptual system is bootstrapped.

Additional examples of schemas which are more biologically motivated are the IMAGE SCHEMAS and MOTOR SCHEMAS described by Lakoff & Johnson (1999). They characterize image schemas as primitive schemas which "structure systems of spatial relations in the world's languages" (35). These include schemas such as PART-WHOLE, SUPPORT, CONTAINMENT, and ADJACENCY among others. The holistic perception of instances of these schemas involves construing multiple entities as fitting within the roles of an overall structure. Perceiving an instance of CONTAINMENT relies on a prefab structure which allows us to, when seeing a ball in a box, understand the ball as a thing contained ('containee') within the box ('container'). There are additionally image schemas which are structured by an Opposition relation, such as STRAIGHT-CURVED and NEAR-FAR.

Motor schemas consist of temporally structured motor commands. For example, the DOOR OPENING schema involves reaching, grasping, twisting, and pushing/pulling (in that order). This kind of schema consists of subroutines that temporally relate to each other in specific ways. Motor schemas are of course dependent on a (typically human) agent as well as various entities or objects that the agent uses the motor commands to act on.

At the more culturally motivated end of the spectrum we find Schank & Abelson's (1977) scripts. I will consider these to be SOCIAL EVENT SCHEMAS which are a subtype of EVENT SCHEMAS more broadly. Event schemas represent knowledge of the entities, actions, locations, changes of state, and times that they co-occur. Events can be intuitively understood as instances of things happening such as a TREE FALLING, the SUN SETTING, a CAR PASSING BY, an ANIMAL DYING, or a TOOL BREAKING. Examples of social event schemas, which are more overtly culturally codified, are SHOPPING, GETTING MARRIED, or PLAYING BASKETBALL. To more fully understand the structure that social event schemas provide we will use BIRTHDAY PARTY as an illustrative example. At a birthday party, we expect there to be a 'celebrated person' (whose birthday it is), 'attendees', 'presents', 'opening of presents', 'cutting of cake', 'singing of Happy Birthday', etc. We also have knowledge of typical locations where birthday parties happen as well as the knowledge that they don't usually happen early in the morning and that usually they occur on or near the celebrated person's birthday. In addition to these core elements of the BIRTHDAY PARTY schema, we have ENCYCLOPEDIC KNOWLEDGE (Langacker 2008) of the various aspects of birthday parties that we've experienced or that we believe to occur. For example, we have knowledge of the differences in the kinds of birthday parties that are thrown for adults versus children as

well as knowledge of the typical price range of gifts given at a kid's birthday party. In the latter case we would expect great variation across individuals and communities as it would be dependent on social values (in a morally neutral sense) as well as socio-economic status. In the human-centered view, both the core knowledge and the encyclopedic knowledge of a type of event are part of its schema because they are associations learned through experience.

The structure of culturally motivated schemas emerges out of statistical knowledge of co-occurrences. Cake with lit candles which are blown out by a celebrated person whose birthday it is frequently occurs at events we call "birthday parties" and therefore serves as a reliable cue for categorizing an event as such. Here we have replaced the necessary and sufficient conditions of formal approaches with conditional probabilities. Given the (perceived) occurrence of a birthday party we are highly likely to categorize someone at the party as the celebrated person whose birthday is being celebrated. Knowledge of roles and actions that are typical of a given situation enable us to perceive people or things as filling those roles and completing those actions if we already perceive ourselves to be in such a situation. Contrariwise, we take observations of people's actions and the features of things in our environment as cues to make inferences about the situations we are in. Thus the claim that our knowledge of the world is chunked into schemas implies complex interactions between bottom-up and top-down processing.

Filling in much of the space between the schemas of sensorimotor perception and socially constructed event schemas are ENTITY SCHEMAS, a term I borrow from Ryder (1994). Entities include people, natural objects, and artifacts. An example Ryder gives is the HORSE schema, which includes knowledge that horses have four legs, a tail, fur all

over their bodies, and that they are typically large (in relation to humans), etc. Ryder characterizes the entity schema of the horse as an abstraction independent of the event schemas a horse participates in. Though we obviously perceive horses to exist independently of people riding them, it seems unnecessary to separate an entity schema from the event schemas it participates in. I will instead note that the schemas for roles in an event schema emerge through interactions between entity and event schemas. There are features that are common to birthday cakes, for example, that allow us to identify them outside of their use in the birthday party ritual. A sheet cake with "Happy Birthday" written in icing is likely to be categorized as a birthday cake regardless of the context. On the other hand, if a lit candle were placed in a pie, if "Happy Birthday" were sung, and if then a celebrated person were to blow out the candle, we could then say that they have a pie for a birthday cake. What this example highlights is that the event schemas an entity participates in and the roles it plays are part of the schema for that entity. The interdependence of things and events extends to any hierarchically structured schematic knowledge: schemas for things and their subparts are interdependent as are schemas for events and their subroutines.

The final schema subtypes I will discuss are SITUATION SCHEMAS and FEATURE SCHEMAS. Situation schemas are scenarios relating multiple entities together. A cup sitting on a table for instance, is a situation that instantiates the SUPPORT image schema. Sometimes the boundaries between situation schemas and event schemas is unclear. If someone is wearing a hat, is this a situation in which the hat is on the person's head or is it an event in which the person is actively wearing the hat? From the human-centered schema view the answer is both, and the emphasis of one over the other is a matter of construal. The fuzzy boundaries between the types of schemas is in fact expected given the gradient

view of categorization that schemas presuppose. Classifying schemas into subtypes is merely a helpful tool for illustrating the breadth of application to which the notion of schemas applies. Features similarly have a perplexing relationship with other kinds of schemas. An example Ryder (1994) gives of a feature schema is INTELLIGENT. Intelligence is clearly different from size or color in that we rely more heavily on event schemas to infer that someone is intelligent. We take for example, someone's success at solving problems, providing insight, or understanding complicated situations as clues to their intelligence. Again, we should not be too bothered by the categorization of subschemas. The point is that qualitatively different kinds of schemas are interrelated and interdependent.

Though much of this discussion has centered on examples of concrete things and the observable events they take part in, schemas apply equally to the patterns found in art, literature, music, and important for this work, grammar. Similarly, schemas are not restricted to categories for which we have words. The statistical learning that drives their creation is always operational and so we should expect schemas to emerge that we are not consciously aware of.

Schemas vary in their degree of specificity and generality and can instantiate each other. If someone opens a door we can view the event as an instance of DOOR OPENING, TRANSITIVITY, ACTION, etc. We have typical ideas of the entities involved in each of these schemas. Actions typically involve animate beings moving around or exerting energy in some way. Transitive situations typically involve an animate being applying energy and altering the state of some other entity. As discussed before, door opening involves an animate being applying a force to an object, typically rectangular, having a knob, and

attached to an entrance with hinges, such that space is then created for that being to pass from one side of a wall to the other.

3.3.2 What schemas are not

The varying degree of specificity of schemas, their ability to instantiate each other, their embeddedness, and complex degrees of association with each other should make it clear that my apparent reference to schemas as discrete things is a convenient fiction. More accurately, the human-centered view of schemas holds that much of our knowledge is represented via a network of schematic associations. Thus "the" schema of PANTS includes probabilistic knowledge of the structure of things called "pants", the actions that involve those things, the materials they are typically made of, and subschemas of pants, e.g., different types of pants. This stands in contrast to the more computationally oriented notion of schemas as lists of slots and fillers. Such lists presuppose the discrete definition of a finite number of slots. This approach is suitable for a rough, computational model of typical events and things, but in real life, aspects of events and things which are not diagnostic can become salient in a particular context. Thus, the slots and fillers approach creates the problem of which slots to include in a schema. A probabilistic approach avoids such arbitrary distinctions while also accounting for typicality judgments. Dimensions of a given schema can vary in their degree of association with instances of that schema. The dimensions and corresponding values that are most diagnostic form the basis of our knowledge of the typical instances of the schema. But if this was all that was included in a schema, our inferential reasoning about things would be quite limited. Instead, we are capable of relying on knowledge of relevant dimensions of even the most general schemas

that we perceive something to instantiate. This can be illustrated by offering a different account of an example discussed by Murphy (1990).

Murphy claims that concept combinations which integrate dimensions that are typically irrelevant for something, such as *cold garbage* or *unsliced typewriter*, are more difficult to understand because the dimensions of modification are not part of the head noun's schema. Because slots and fillers represent the typical structure of things, one has to create the slots of 'temperature' and 'slicedness' for the schemas for GARBAGE and TYPEWRITER respectively to understand such phrases. A probabilistic and interdependent view of schemas enables us to understand *cold garbage* and *unsliced typewriter* on the basis of our schematic knowledge of PHYSICAL THINGS and our embodied schematic knowledge of TEMPERATURE and SLICING. It is physical things which can be hot or cold and certain types of physical things which can be sliced. *Cold garbage* can be understood because PHYSICAL THINGS are a core part of the TEMPERATURE schema. *Unsliced typewriter* can be understood (and judged as a strange thing to say) because of our knowledge that soft and malleable things are more readily sliced. Thus our specific experientially driven knowledge of the physical properties of typewriters can be contrasted with the physical properties of things that are easily sliced and our embodied knowledge of what slicing entails. There is no need to declare the presence or absence of a slot in a schema because schemas are more of a shorthand for probabilistic knowledge of the properties, features, and actions associated with things and events.

It might be tempting to avoid the whole issue by claiming that GARBAGE and TYPEWRITER INHERIT schema dimensions from the broader schema of PHYSICAL THINGS, but this view is again, overly computational. It implies that necessary and

sufficient conditions construct the different categories that things belong to. This point is particularly relevant for reasoning about social situations, which are much less objectively construed as instances of different types of social event schemas. In place of inheritance, we have the more flexible view that if a thing, X, is perceived to instantiate schema Y, then its potential role in schemas which often involve instances of Y becomes more relevant.

3.3.3 Schemas and noun-noun compounds

In this chapter I have described a wide variety of schema types. In addition to pointing out that schemas are a powerful tool for understanding many social and cognitive phenomena, doing so allows us to understand how language comprehension fits within a more holistic view of human experience. That is to say, schemas are theoretical glue which can help us understand how mechanisms for understanding NN compounds relate to a particular view of language and of social interaction. This section begins with a high-level description of those interactions across different schemas which are involved in language and then describes more specific aspects of NN compounds.

In the human-centered schema view, people continually construct and update mental models at varying scales. These include structured understandings of their lives at a broad level, as well as their immediate physical and social situations at a more local level. Acting, reasoning, and making sense of immediate situations is guided by schemas based on prior situations. People have statistically structured knowledge of different social contexts, the types of roles people play in those contexts, the types of people who play those roles, the types of speech events that are appropriate for performing or establishing those roles, and so on. In the midst of an interaction, a context model includes within it schematic representations of interlocutors' minds. These can in turn contain representations of other

people's representations of our own minds. I assume, for example, that you assume that I share certain knowledge or that I say things for a general reason that is relevant to our presumably, mutually understood context. Such recursive mindreading (Tomasello 2008) shapes what is said and enables the comprehension of the general point of an utterance. All of these types of schemas are dynamic: new, novel, active schematic models are continually updated based on incoming information and updates to other levels of models. For example, if something happens for me to understand our immediate social context differently, I accordingly will be motivated to understand your utterances as having potentially different meanings.

At what we might call a "lower" level, we have knowledge of the conventionalized ways language is used to prompt for understandings about the world. This includes knowledge of how words and syntactic structures are used to describe different things and situations. This knowledge is represented as reference schemas, which are created from situated experiences of people using words and phrases to direct our attention to various states of affairs. That is to say, we are capable of referring to things because of our experience-based knowledge of how reference is done. We also have knowledge of how language forms are used to prompt for representations of various schemas as well as other people's minds. Such space builders (Fauconnier 1994) enable holistic understanding of utterances, not just their referential meaning but also how they should be taken as prompts to update our mental models of current situations. A hypothetical situation can be used to demonstrate these complicated interactions and also to highlight the relevance they have for NN compound comprehension.

Suppose that "George" is my roommate and I know you know this. I say to you *For some reason, when George came into the kitchen he was surprised to find a fish bag*. Understanding this utterance involves more than assessing the propositions that George entered a kitchen and was surprised to see a fish bag (whatever that is). You must build multiple belief spaces, one for George's expectations about what sorts of things should be in the kitchen, and one for my apparent confusion about George's surprise (as prompted by *for some reason*). Interestingly, your interpretation of the novel compound, *fish bag*, will interact with those belief spaces as well as your previously constructed schemas for me and George. If George and I both like to fish, then *fish bag* might be interpreted as a bag for holding recently caught fish. Understanding the situation I am describing might then involve trying to understand why George was surprised in this particular situation to find something that might ordinarily be in the kitchen. If I work at a department store, however, you might be more inclined to interpret *fish bag* as a bag with images of fish on it. In this case, your model for the motivations of George's surprise might relate to your knowledge of my fashion sense. Whether I sell bags for a living or like to fish, your inferences about *fish bag* could also be influenced by your schemas for me and George. Imagine how different understandings of the utterance and of the referential meaning of *fish bag* could be influenced by whether you think: that you and I are currently gossiping; that I am trustworthy; that George and I get along; that I am considerate; that George is easily surprised; that I am messy and George is tidy; that I have no disposable income to spend on bags; that George detests fish.

Your comprehension of this utterance is additionally guided by situated simulation. If you have been in my and George's kitchen before, you might actually imagine the scene

unfolding from a particular perspective, perhaps using a point of view from which you could see George enter the kitchen. Depending on your specific knowledge of the layout of the kitchen and on what you think a *fish bag* might be, you could be motivated to imagine the bag in different locations. This simulation, like the qualitative understanding of *fish bag*, serves to help make sense of the intended meaning of the utterance and appropriately update your mental models of me, George, our living situation, and an innovative category of items called "fish bags".

The human-centered schema view helps make sense of how our general understandings of our physical and social worlds interact during language comprehension. It is consistent with an emergent and gradient view of categories. It is consistent with a constructional and EMERGENT (Hopper 1987) view of grammar. It sheds light on what context is and how it shapes our understanding of language on the fly. It is consistent with recent findings that much of cognition is embodied. In short, it neatly integrates some of the social motivations and cognitive capacities that make language work.

I will now discuss more specifically how the human-centered schema view handles some of the key issues of NN compound comprehension. NN compounds are understood by constructing a schema for a situation or a thing by integrating schemas for the noun concepts with schematic world knowledge. As discussed in Section 3.3.2, the representation assumed is different from the schema modification view (Murphy 1988, 1990) and the augmented schema view (Wisniewski 1997, 1998) in that there are no slots or fillers in such schematic representation. This enables schemas to be more dynamic and flexible. The view of schemas as probabilistic association also enables conceptual blends to be motivated by knowledge of the schemas that schemas are associated with. We are not

restricted to a list of facts or features about the noun concepts or the situations in which they are situated.

In normal discourse contexts, the construction of a blend representing the referential meaning of a NN compound serves the ongoing simulation of the situation being referred to. The blends which produce interpretations of NN compounds encountered in isolation, as in experimental contexts, can be thought of as impoverished versions of the same thing. If I interpret *fish bag* as a bag that holds fish, I have to be able to simulate this scenario. Thus the choice among potential blending paths is guided by schematic knowledge of the types of situations that occur in reality and types of situations that are possible. If I have specific knowledge that there are bags that hold fish, this would greatly motivate this interpretation. If I don't have such knowledge, the interpretation could still be motivated by my general familiarity with containment schemas, my knowledge that bags are meant for containing things, and that some fish come in sizes that allows them to be stored in bags. This integration of specific knowledge about what is possible for the two noun concepts is what Lynott & Connell (2010b) call AFFORDANCE MESHING. This innovative use of the idea of affordances highlights not just what sorts of activities a thing affords from a human perspective, but also the sorts of situations and relations two things afford jointly. Thus, *truck bag* would be less likely to be interpreted as 'a bag for holding trucks', because bags are not typically large enough to contain trucks.

The role of affordances and knowledge of what situations are normal in the world speaks to the preference for interpretations which assume real-world plausible situations. This plausibility constraint is not just a reflection of the fact that it is easier to imagine likelier situations, it also reflects dialogic reality. We know from experience that people

usually refer to situations in the world that are in fact real. So our preference for real-world plausible meanings is equally motivated by our discursive habits. Frequency effects are similarly motivated by knowledge of prior usage. As both Ryder (1994) and Gagné & Shoben (1997) would predict, one's knowledge of how nouns are used in compounds will influence how one interprets a novel compound. Knowledge that a particular noun is used as the modifier or head with a particular relation will motivate consideration of analogous interpretations for compounds with analogous structures. Similarly, knowledge of a single compound can form the basis of an analogy motivating the interpretation of a novel compound, as the discussion of Ryder's (1994) example of *ice legs* in Section 2.2.2 demonstrated.

In a more general sense, there is a preference for dialogically plausible interpretations of NN compounds. What this type of plausibility speaks to is, given some situation, why would someone use a particular compound? Interpretations of compounds for which there are reasonable answers to this question are generally preferred. As one example, compounds are the result of a word formation process, and as such would not be expected to be created to refer to things which already have conventionalized names. Thus I might be unlikely to interpret *head shirt* as 'a hat' because I would wonder what someone's motivations are to call it that (there are of course exceptions to this, especially found in humor). Another influence on dialogic plausibility is diagnosticity, which Costello & Keane (2000) also take to be a major constraint on interpretations of novel compounds. It would be strange to refer to a planet as a *space planet*, for example. A planet being found in space would not be diagnostic of any particular subgroup of planets nor of any specific planet. Interpretations will avoid such redundancy, as Downing (1977) observed.

Diagnosticity is also important for property-based interpretations (Costello & Keane 2000). It would be strange for me to call a particularly heavy book a *chair book*. Though plenty of chairs are heavy, when I think of the category 'heavy things' I don't particularly think of chairs. It might be more appropriate to call it an *anvil book* because it is analogously heavy for its size. One can quickly see that dialogic plausibility is not a single monolithic effect. It is in essence a way of thinking about Gricean (1975) maxims and how the assumption that people say things for reasons guides interpretation of ambiguous language such as NN compounds.

Because relation-based interpretations involve constructing a scenario in which the two noun concepts are involved, our specific statistical knowledge of when those two concepts (or things that the nouns refer to) co-occur is a useful guide. Thus *concert stamp* could easily be interpreted as a stamp that is placed on someone's hand when they pay and enter a venue for a concert. Such an interpretation is guided by the specific schematic knowledge of what happens at a concert.

The human-centered schema view makes no hard claims about the time course of NN compound processing, though a tentative hypothesis of parallel processing of property- and relation-based interpretations seems motivated. Recall that CARIN and RICE treat property-based interpretations as resulting from the Resembles relation while the augmented schema approach views them as products of different processes. The problems with the CARIN and RICE treatment of property-based interpretations was discussed in Section 2.3.2. The augmented schema view argues that property-based interpretations and hybrid interpretations are distinct from relation-based interpretations because they require structure mapping between the two noun concepts. One problem with using the comparison

process as evidence for distinct processes for property- and relation-based interpretations is that it is unclear how relation-based interpretations could happen without some sort of comparison. Going back to the example of *fish bag*, the choice of the interpretation of 'bag for holding fish' is constrained by our knowledge of what sorts of things are kept in bags. The likelihood of that interpretation might be weakened by the fact that most people don't carry animals (dead or alive) around in bags. On the other hand, it could be helped by knowledge of the fact that bags are used to carry things that would weigh a similar amount and put similar stress on a bag. To be fair, there is a clear difference between this sort of comparison to general sets of things and the specific comparison between nouns that Wisniewski & Love (1998) suggest is involved in property-based interpretations. But it is easy to imagine relation-based interpretations motivated by more explicit comparisons. For instance *book stick* could be 'a stick for writing'. The fact that sticks and pencils have a similar shape and the fact they afford holding in a similar manner could help motivate this interpretation.

In addition to the fact that the underlying processes might not be as different as Wisniewski & Love indicate, the idea that one process is chosen over the other on the sole basis of similarity between the two constituents would seem to rule out any comparison of plausible interpretations of different types. It seems likelier that some degree of comparison of potential property- and relation-based interpretations occurs at the beginning and that on the basis of that comparison, one of the routes is then stuck to in order to complete the interpretation. At any rate, a crucial difference between the human-centered view of schemas and the augmented view is that comparison is assumed to motivate relation-based compounds as well.

Property- and relation-based interpretations are also understood as less of a dichotomy in the human-centered view. Take for example compounds with conjunctive meanings, such as *student-athlete*. This compound is best understood as referring to a person who is both a student and an athlete. Whether you think of them as an athlete who is also a student or a student who is also an athlete is somewhat arbitrary. The point is that in this example, as in hybrid interpretations, there is neither mapping of features from the modifier to the head nor construction of a scenario relating a student to an athlete. We have instead, knowledge of the two concepts and construction of a schema (in this case, for a person) in which both concepts play a role. This is something that all NN compound interpretations have in common in the human-centered schema view. They all result from taking a NN compound as a prompt for schematically structuring a simulation of some kind.

The resolution of ambiguity is understood to be the result of all the previously discussed factors that guide NN compound interpretation. The competition, then, is not among discrete relations or interpretation strategies. The competition that takes place is among different interpretations, or more specifically among different blending paths which produce different simulations. This allows us to understand how an interpretation can be motivated by multiple schemas. Interpreting *fish bag* as ‘a bag for holding fish’ would be an instance of the constructional schema X-bag, where X-bag is interpreted as a bag for holding X. At a purely conceptual level, it is also an instance of CONTAINMENT, which bags are known to participate in. Recall that people often provide surprisingly detailed interpretations of novel compounds in experimental settings. If *fish bag* were interpreted specifically as ‘a bag for transporting gutted fish home after a fishing trip’, then it would of course also instantiate a TRANSPORTATION schema. The situation assumed by this

interpretation also instantiates the PURPOSE schema because it is a bag with a dedicated purpose. The competition in NN compound interpretation is between potential situations to be simulated. Multiple situations could potentially be entertained at the beginning stages of interpretation, with one winning out because of real-world and dialogic plausibility. Multiple schemas could then be called upon to flesh out the interpretation to whatever level of detail is felt necessary or possible in the context.

Just as Fauconnier & Turner (2002) argue, the human-centered schema view assumes that conceptual blending is an active process in all language comprehension. This applies to both descriptions of mundane, everyday affairs and comprehension of lexicalized compounds. There is a variety of experimental evidence (Gagné & Spalding 2004, 2009; Gagné et al. 2005b; Spalding & Gagné 2011; Ji et al. 2011) supporting the idea that the meaning construction process involved in interpreting a novel compound is also active in processing lexicalized compounds and that this occurs simultaneously with retrieval of the lexicalized meaning. Ji et al. (2011), for example, found that aiding the decomposition of a NN compound has a facilitative effect for transparent compounds and a processing cost for opaque compounds. Decomposition was aided by varying in one experiment whether the constituents were separated by a space and in another whether they were presented in different colors. The results were interpreted to mean that both the processes of retrieving a lexicalized meaning and constructing a meaning are active in comprehension of a lexicalized compound. It is facilitative for transparent compounds because two processes guide the language user to the same interpretation. There is a processing cost for opaque compounds because the constructed meaning has to be inhibited in order for the lexicalized meaning to win out. These results would also be predicted by the human-centered schema

view as NN compounds can instantiate multiple reference schemas: one invoking knowledge of prior use of the specific word pairing with a particular intended meaning and one invoking knowledge of how NN compounds are constructed to create words and refer to things in general. Additionally, considering that the difference between novel and lexicalized compounds is gradient, it is difficult to know on what basis the meaning construction process could reliably be turned off.

3.3.4 Testing the model

The human-centered schema view can be tested straightforwardly by comparing its ability to explain NN compound meanings that occur in the wild with the ability of other theories to do the same. The framework predicts that some lexicalized compounds cannot be described in terms of relations between nouns. This is because what is assumed to be more important in understanding a novel compound is the construction of a schema in which each noun concept plays a relevant role. This does not have to express a relation between the nouns so much as between each noun and the interpretation's schema. A nonschematic approach in the flavor of CARIN and RICE would not make such a prediction. The human-centered view also makes predictions which can be tested experimentally. The reliance on schemas at every level predicts that high level conceptual schemas can guide interpretation of NN compounds and that priming for this can be achieved without presenting participants with analogous compounds beforehand. This sort of priming would provide strong experimental evidence for the role of schemas in NN compound interpretation in general. Because it would not relate to the use of the constituent nouns in previous compounds, CARIN and RICE would have no explanation for such results. Finally – and this goes beyond the scope of this dissertation – the framework can be tested by generally seeing

how well it makes sense of aspects of context that guide interpretation of novel compounds. This last test risks being speculative, but such speculation seems necessary for a general understanding of how NN compounds are understood within the context of normal human communicative concerns. This sort of analysis could in turn inform future experimental work.

3.3.5 Summary

From the human-centered view, schemas represent probabilistic knowledge of structured co-occurrences learned through experience. This applies to patterns observed in social interaction, in the physical features of things, in the ways language is used to prompt for different understandings, and in many other realms. Foregrounding the social concerns of humans allows us to understand how schemas play a much bigger role than simply representing structured knowledge of noun concepts. It can help us understand the wide variety of factors that guide NN compound interpretation. It also enables us to integrate insights on NN compound meaning and general observation of schema-guided social behavior. In short, a human-centered approach not only allows us to understand NN compounds but provides theoretical glue for a holistic understanding of how various social and communicative concerns are integrated into a coherent flow of experience.

3.4 Chapter summary

The human-centered view of schemas demonstrates that a schema-based account of NN compounds can be provided which accounts for a broader array of cognitive, linguistic, and social phenomena. It differs from the “slots and fillers” approach by recognizing the

socially situated nature of language and emphasizing that because categories are not rigid, schemas must accordingly be flexible and dynamic. A probabilistic approach not only allows for this flexibility but enables more complex interdependence among schemas. An understanding of such top-down bottom-up interactions enables us to theorize more explicitly about how schemas for social situations and interactional contexts can influence the perceived referential meaning of novel NN compounds. The resulting view is something that can be tested qualitatively against naturally occurring compounds and experimentally by priming people with high level conceptual schemas.

The human-centered schema view provides evidence for the external validity of schemas in general. The breadth of this theoretical coherence can be contrasted with the narrow applicability of the claims of CARIN and RICE resulting from their simultaneous reliance on relations and rejection of schemas. Even if this apparent contradiction were accepted, for CARIN and RICE's claims to be taken seriously, they would also have to explain either how the research reviewed in Section 3.2 can be accounted for without schemas, or why comprehension of NN compounds would not involve schemas while so many other aspects of cognition appear to be schema-dependent.

Chapter 4

Analysis of lexicalized compounds

This chapter compares the generalizability of the human-centered schema view and nonschematic relational approaches such as CARIN (Gagné & Shoben 1997) and RICE (Spalding et al. 2010; Gagné & Spalding 2013). Specifically it demonstrates that CARIN and RICE's rejection of schemas creates pervasive gaps in their ability to generalize to naturally occurring compounds. For expository simplicity, RICE will often be used as a stand-in for both CARIN and RICE because it makes the same key assumptions and is considered by its authors to be a refinement of CARIN. It should therefore, if anything, be more capable of accounting for compound meaning. In Chapter 2, gaps in the explanatory power of CARIN and RICE were touched on but were not analyzed in detail with respect to naturally occurring compounds. By comparing RICE's and the human-centered schema view's ability to explain the meanings of randomly sampled NN compounds, we put our criticisms on firmer empirical footing. Such a test is fair because both RICE and the human-centered schema view claim that their posited comprehension mechanisms apply to both novel compounds and transparent, lexicalized compounds.

Because the focus is on transparent, lexicalized compounds, the task of the analysis described in this chapter is to see if each theory is capable of explaining why the compound's meaning is obvious. That is to say, if you heard the term for the first time,

what type of information would be required in order for it to make sense and for it to be the unambiguously correct interpretation? This highlights the fact that meaning can only be transparent with respect to particular background information. One of the recurring problems for RICE to be demonstrated is that this background information is often schematic.

4.1 Review of theoretical claims

Though RICE and the human-centered schema view agree that a comprehension mechanism for NN compounds should apply to both novel and transparent lexicalized compounds, they disagree as to how this is accomplished. The human-centered schema view assumes that NN compounds are understood by integrating schemas for each constituent noun concept with each other and with other schemas for concepts, things, and events in the world. One noun can refer to an entity or concept which fills a role in the other noun's schema. Alternatively, the two nouns can play salient roles in one or more schemas representing our structured knowledge of the world. Because schemas are emergent and represent the probabilistic structure of experience, they can be highly abstract or arbitrarily specific. Specific schemas are thus capable of instantiating multiple, relatively general schemas. No strong claims as to processing stages are assumed by the human-centered schema view, though the integration of schemas is understood to be a complex combination of top-down and bottom-up processes. These processes are primarily guided by real-world and dialogic plausibility. That is to say, comprehension of NN compounds is constrained in part by a preference for interpretations which reflect our understanding of

known, likely, or possible events in the world as well as an assumption that the individual nouns in NN compounds are salient or relevant to the overall compound's meaning.

RICE assumes that NN compounds are understood by competition among relations and discrete selection of one and only one of them. The relation selected connects the two nouns and this relation between nouns forms the basis of the compound's meaning. The theory is noncommittal as to the number of relations or their level of specificity. However, it should not allow arbitrarily specific relations which are represented by particular lexical items. Doing so would contradict the theory's reliance on general relations while making it indistinguishable from schema-based accounts, which it claims not to be. The possible choices of relations are motivated first by the relative frequency with which a NN compound's constituents are associated with particular relations. Knowledge of each noun concept then plays a role (in an unspecified way) in constraining the choice of relation. The selection of a relation motivates a "gist" meaning which is then elaborated. For example, if *stone box* is interpreted as 'a box for stones', one could then elaborate the meaning to infer that the box is particularly sturdy and perhaps made of metal or wood rather than cardboard. The human-centered view allows such elaborative inference to occur but does not assume that it always does, nor that the specifics of NN compound meaning arise from it. Rather, specific aspects of NN compound meaning can sometimes be imported directly from schemas that are used as the basis for interpreting the compound.

4.2 The data

The Corpus of Contemporary American English (Davies 2008-), henceforth abbreviated as COCA, was used as the source of NN compounds. The corpus features more than 520

million words taken from five genre types: fiction, magazine, newspaper, academic, spoken. The source texts date from 1990 to 2015. Each word in the downloaded corpus comes pretagged for part of speech, lemma, source text, and genre. This tagging was used to subset the data into pairs of consecutive nouns. A database was then created where each row represented a unique NN lemma pairing. To create a frequency-balanced sample of 1000 NN lemma pairings, 200 were randomly drawn from each of the five quintiles of those occurring at least 20 times in the corpus.

The sample of 1000 NN lemmas was then filtered to ensure that all items were in fact NN compounds and to ensure that the compounds were typical of the sort of compound analyzed by leading theories. For each compound, examples of the sentential context in which it occurs were analyzed. If either noun appeared to be used more as a verb or some other grammatical category within most of its examples, it was removed from the sample. For example the lemma 'money talk' was removed because most of its occurrences were within the expression 'money talks', where *talk* is clearly a verb. Additionally, intuition was relied on to check whether constituents could reliably be thought of as nouns. Lemmas with a constituent which was arguably more of an adjective based on intuitive knowledge of how it is generally used were also removed. Similarly, if a lemma seemed to correspond to a compound of a verb and a noun, it was removed. 'Jump rope' was removed for this reason.

Because most of the literature on NN compound comprehension focuses on compounds consisting of just two nouns, NN lemmas which were embedded within larger constructions or noun-noun-noun compounds were also removed. NN lemmas including titles such as *Doctor Fulton* were removed as these are rarely discussed in compound research, perhaps

because of their lack of ambiguity. Proper noun compounds with a naming function such as *Sonoma County* were removed for the same reason. If one of a NN lemma's constituents seemed to primarily appear within the compound itself, it was removed. This was because the theories of NN compound comprehension attempt to explain how knowledge about each noun (on its own) can be combined with other knowledge to yield the compound meaning. *Chaise lounge* was removed for this reason because the lack of occurrences of *chaise* in the corpus outside of this compound context probably indicates that people do not have a notion of *chaise* that is independent of the concept of a chaise lounge. NN lemmas were also removed if they did not correspond, for any reason, to one dominant compound.

NN lemmas with nouns which are nominalized forms of verbs were included because they are included in the materials of many experiments purporting to provide evidence for CARIN/RICE. One exception was compounds where the head noun is of the form Verb + *-er* and the compound meaning seems more motivated by the verb stem meaning rather than a lexicalized meaning of the head noun, such as *nature lover*. Though the human-centered schema approach would analyze these as subschemas of NN compounds, compounds of this form are not typically considered in the psycholinguistic literature. Not all compounds of the form Noun + Verb + *-er* were removed, however. *Geometry teacher* was included because *teacher* has lexicalized meaning which seems to help motivate the compound's meaning.

Finally, it was confirmed that each compound was arguably lexicalized to some extent. If a compound did not occur in multiple texts, it could not reasonably be assumed to be transparent and conventionalized for a group of English speakers. Such an assumption

would be particularly problematic if, for example, the compound only occurred in a single work of fiction. If it occurred in just one source but seemed to plausibly be a conventionalized term, a quick Google search was carried out to verify that it had usage beyond that one source.

Attention was paid to the exact form of the instances of each NN lemma. If the first noun was typically plural, then the compound for analysis was recorded as such. The whole process yielded 724 NN compounds, which are listed in Appendix A. Because construction of the sample relied on COCA's part of speech tagging of distinct words, it systematically excluded compounds that are conventionally written as a single word, such as *snowflake*.

4.3 Compound analysis

The qualitative discussion of NN compound meaning that follows is organized along the lines of the different categories of explanatory problems that RICE's assumptions produce. The subsections should not be viewed as a semantic taxonomy. Many of the example compounds discussed could be discussed in multiple subsections. Dividing the analysis in this way is meant merely as a means of providing a holistic understanding of the problems that a nonschematic view of relations produces. By approaching RICE's explanatory potential from various angles, the pervasive problems resulting from its exclusion of compounds are revealed.

4.3.1 Too many relations

As discussed in Chapter 2, a recurring problem faced by nonschematic relation-based approaches is the problem of too many relations. In this situation a true understanding of a

compound's meaning cannot be simplified to a single relation between the two constituents. Two or more relations between the nouns are a necessary component of the compound's meaning. This is problematic for RICE because it assumes that a single relation between the nouns is selected to form the basis of the compound's meaning. Analysis of such compounds under the RICE framework results in arbitrary selection of a relation.

Christmas music – Within the RICE framework, the meaning of *Christmas music* is motivated by the selection of a single relation resulting in a gist meaning such as 'music for Christmas', 'music about Christmas', or 'music during Christmas'. But which of these should be selected and on what basis do the other relations emerge in the compound's elaboration? If For is selected as the relation (presumably in a Purposive sense), it seems unlikely one could truly understand the term without holistic knowledge of holidays, Christmas in particular, and the various ways music is used to celebrate or mark special occasions. It is, of course, more precise to say that Christmas music is music for CELEBRATING Christmas. But this is only obvious because of the social schemas we use to understand holidays, celebration, and so on. The human-centered schema view on the other hand does not have to make arbitrary decisions about relations. Structured knowledge of holidays, how they are celebrated, the role of music in such celebrations, and specific knowledge about Christmas can be accepted wholesale to structure our understanding of what Christmas music is. In essence, we consult schemas of what goes on around Christmas time to find instances of music that we can call *Christmas music*. This includes music about Christmas, music sung or listened to leading up to Christmas, and instrumental music written for Christmas time church services. In all cases, the relevance of the term *Christmas*

music and the successful identification of referents is made possible by knowledge of how Christmas and other holidays are celebrated and the salient roles music plays in such schemas.

steam room – Within the RICE framework, one would have to arbitrarily decide whether a steam room is 'a room for steam', 'a room that has steam', 'a room that uses steam', or 'a room where steam is located'. Despite the fact that *steam room* seems fully transparent (it is entirely obvious how the meaning of *steam* and of *room* are related to the compound's meaning) none of these individual relations could motivate a substantive understanding of *steam room* without holistic knowledge of what a steam room is. Such knowledge is nothing if not schematic. It is not just a room with steam in it or a room that uses steam in some way. We know that it is specifically a room that is hot and in which steam is produced to raise the humidity of the room so that people can sit in the room, relax, and get out a "good sweat". The schema for *steam room* includes the contexts in which people go to a steam room (often after exercise), the fact that people are typically naked or wrapped in a towel when relaxing in a steam room, as well as the motivations that people have for using them. One's schema could be more specific than another's based on one's knowledge of steam rooms and previous experiences with them. Crucially, the level of specificity of one's knowledge of steam rooms determines the level of specificity of understanding of the phrase *steam room*. Specifics do not seem to be elaborated from some gist understanding. The courser grained relations that could be said to apply to the meaning of *steam room* are motivated by specific schematic knowledge.

toe ring – The meaning of *toe ring* could obviously be paraphrased as 'a ring for one's toe' but the fact that this would include a locative relation between 'toe' and 'ring' could

not be explained without recourse to our schematic knowledge of rings. This means that for RICE, it is arbitrary to select For over Located. Schemas handle this compound much more easily. Our schema for 'ring' includes the knowledge that it is circular jewelry worn around the finger. The appropriateness and plausibility of understanding *toe ring* as 'a ring worn on one's toe' is motivated by combining this schema with our analogous understanding of the structures of hands/fingers and feet/toes. What makes the meaning of *toe ring* so obvious is the structural similarity of toes to the thing that normally fills the analogous role in the ring schema (fingers).

RICE's reliance on the selection and elaboration of a single relation between nouns makes it incapable of handling NN compounds whose meanings necessarily involve multiple relations between nouns. The selection of a particular relation is arbitrary and often, these compounds are meaningful and transparent only given a holistic backdrop of knowledge which can only be viewed schematically. Additional compounds which pose this problem for RICE are *advice column, bean field, body fatness, brick kiln, Christmas dance, church lawn, clothing business, cotton field, debt burden, deer woods, e-mail server, food crops, forest elephant, ground beetles, home furnishings, juice glass, land mammal, museum building, pickle barrel, portrait studio, restaurant dinner, salmon habitat, sound technician, soup bowl, trading floor, trophy room, university endowments, usb drive, weapons plant,* and *yard work.*

4.3.2 Frame semantics of constituents

Many compounds are problematic for RICE simply because their constituents are prime examples of lexical meaning being schema-based. That is to say, no real understanding of the word can be had without relating multiple entities or roles together in a particular way.

This section provides a brief description and examples of some of the most common types of frame semantic properties of constituents encountered in the COCA sample.

4.3.2.1 Rates and other relational measures

Many compounds from the COCA sample which are difficult to analyze in terms of a general semantic relation feature a constituent which invokes a measurement relating two other measures, values, or quantities together in some way. Many of these are best paraphrased as 'Y of X' (where the compound is of form XY) rather than with any general semantic relation linking the two nouns. Notably, "of" does not refer to any particular relation. These compounds are problematic for RICE because usually the most relevant relation is a relation within the noun invoking a measurement of some kind. Even when the two nouns can be linked by some general relation, the specificity of one's understanding of the compound depends on the specificity of one's knowledge of the particular measure.

chlorine level – This is an interesting example because disambiguating what sort of scale is invoked by *level* is dependent on our schematic knowledge of situations that chlorine is involved in. On its own, *level* simply invokes a dualistic scale of measure with opposite ends representing more or less of something. The situations in which chlorine is salient in most people's lives is its sanitation role in drinking water and swimming pools. We know that a certain amount is needed in order for it to effectively kill germs but that too much chlorine in drinking water will make the water taste bad or make it unsafe to drink. So we are concerned with the amount of chlorine in water per volume. It is this holistic knowledge of the situations in which we encounter chlorine and what its specific relevance is that makes it obvious that *level* should be interpreted as a measure of the concentration of chlorine in water. This is despite the fact that there is no explicit mention

of water in the compound. No simple semantic relation between nouns can provide an adequate paraphrase of this compound, let alone motivate an understanding of it to a functional level of specificity. Other compounds from the sample which integrate world knowledge and schemas for measures of concentration are *ozone concentration*, *pesticide levels*, and *serum concentration*.

gold price – Other compounds express a relation of equivalence between two amounts through the internal schematic structure of one of the constituents. *Gold price* for example is understood as an expression of the amount of some currency that is viewed as equal in value to some given amount of gold. This is possible because the PRICE schema includes within it an 'amount of currency' that is given by the 'buyer' to the 'seller' in exchange for a certain 'quantity of some valued thing'. The compound is intuitive because 'gold' is a strong candidate for filling the role of 'valued thing'. It is only by linking 'gold' to this role within the PRICE schema that the two concepts are connected. Otherwise a simple relation linking the two nouns is not informative. Ignoring the fact that a general relation linking the two nouns short circuits the schematic knowledge of prices that is needed to understand the compound, it might seem like RICE could handle this example with 'price that gold has'. This route, however, is problematic because it is not clear what relational sense of *has* is being used. Here it references neither ownership nor a part-whole relation.

Other compounds from the sample which contain constituents whose meanings are understood as relating two things together with an equivalence relation are *conversion rate* and *power conversion*. Really, rates of any kind are problematic for RICE because they relate two things together within the context of a specific schema. The compound meaning is then likely to arise from a complex integration of the two constituents' schemas.

Additional compounds from the sample that pose this problem are *plant productivity*, *ratings game,* and *summer rates*.

4.3.2.2 Dualistic measures

Similar to but more abstract than the rates and other measures discussed in the previous section are compounds which contain a constituent that prompts for a dualistic measure of some kind. In each case, constructing a functional understanding of the compound involves integrating the dualistic structure of one constituent with the specific schematic knowledge of the other constituent. Crucially, the level of detail of one's schematic knowledge determines the level of specificity of one's understanding of the compound.

bond rating – This compound could plausibly be paraphrased as 'a rating for a bond' but a Purposive relation cannot give any detailed understanding without schemas. Knowing that the Purposive relation is appropriate is dependent on schematic knowledge of both ratings and bonds. Ratings are measures of quality of some aspect of something. They are created by a person or group and made available to others to help inform their decision making in some way regarding the thing being rated (Should I avoid it? Should I watch it? Should I buy it? Etc.). In other words, Purposive relations are appropriate and obvious and lead to transparency of a compound only if one has schematic knowledge of the intended function of one or both of the noun concepts (more on this topic in Section 4.3.3.1).

One could vaguely understand *bond rating* as 'a rating for a bond' even with no knowledge of what bonds are. But to understand *bond rating* in any functional way, you need a more complete understanding of the holistic structure of bonds. A bond cannot be defined in terms of a list of propositions. It is a schema with specific roles and relations. Within the BOND schema, there are two 'parties' with one party loaning money to the

other. The ‘borrower’ agrees to pay back the ‘investor’ at a certain ‘rate’ on a certain ‘date’. Ratings could potentially be made for various aspects of bonds, but in practice, *bond rating* refers to a measure of the reliability of the issuer of the bond. It is a measure of how confident one should be that one would be paid back when the bond matures. An even more detailed understanding of *bond rating* would come from an understanding of who the rating agencies are, what their biases might be, and on what basis they assess a government’s budget practices and its willingness to pay off its debt. Understanding *bond rating* involves mapping a dualistic scale of quality onto a scale of confidence from the rating party onto potential outcomes in bond scenarios involving a particular bond issuer. It seems highly implausible that a general Purposive relation linking the two nouns can motivate functional understanding of *bond rating* without such schematic integration.

Other compounds from the sample whose meaning depends on schematic mappings between constituents where one is dualistically structured are *accountability measures*, *acuity score*, *age category*, *frequency spectrum*, *image scale*, *magnitude scale*, *proficiency level*, and *status level*.

4.3.2.3 Words for structures or parts of structures

Several compounds in the sample are dependent on schemas either because a constituent references a type of structure or organization, or it references a part of such a structure. In such cases, a simple paraphrase with a relation linking the nouns might be available, but it seems unlikely that a meaningful understanding of the compound could arise without specific knowledge of the sort of structure referenced.

drug unit – Units subdivide something into chunks that are centered around some theme. But it is implausible that a functional understanding of *drug unit* could emerge from

a general topic relation without schematic knowledge. The obviousness and relevance of the term stems from knowledge of how police departments are structured and some basic knowledge of laws. Laws establish certain actions to be illegal. Many laws pertain to drugs. But this cannot be viewed as nonschematic propositional knowledge about laws or drugs. We know specifically that the government has established that possessing or selling certain drugs is illegal and that there are consequences if one does the specific actions with specific drugs that are forbidden. In particular, one might be arrested and convicted of a 'crime', which consists of doing the things the government said one is not allowed to do with particular drugs. For efficiency and efficacy, there are specialized units within police departments and other law enforcement agencies that are dedicated to investigating particular categories of crimes. What makes those categories coherent is that they each correspond to some type of activity or actions with particular things that are illegal. Each unit is a structured team of law enforcement professionals whose work is dedicated to investigating those particular crimes. Thus a functional understanding of *drug unit* requires not only an understanding of law enforcement being broken down into specialized units, but also schemas for CRIME, LAW, INVESTIGATION, GOVERNMENT and so on. *Unit* invokes organizational structure in general and its co-occurrence with *drug* in *drug unit* guides us to think of the structure of law enforcement agencies in general. Thus the very general structural schema invoked by *unit* has to be integrated with schematic world knowledge in which the other constituent potentially plays a relevant role. Other compounds that involve general structural terms that must be understood by linking that structure with other schemas are *evaluation system*, *flower arrangement, gender stereotypes*, *genome sequence*, *land-use patterns, patronage network*, and *process step*.

4.3.2.4 Schemas of human activity

A common way in which compounds in the sample are schema-dependent is where one constituent can only be understood with respect to a broader schema of human activity. These aren't necessarily social scripts through which the constituent is understood. Often it is a much higher level organization of human activity that the constituent's meaning depends on. Sometimes, however, understanding the higher level organization of social roles is dependent on a variety of social scripts. And whether or not the compound can be paraphrased with a simple relation between nouns, those social schemas must be invoked to understand the compound's general referential meaning and the relevance of each constituent.

avoidance behavior – *Avoidance* refers to a (typically social) schema where someone perceives some other entity as something that they do not want to be around, that they don't want to interact with, or that they want to generally "steer clear of" for one reason or another. The person then makes choices that enable them to stay away from the thing or person to be avoided. This is clearly schematic in that understanding the term requires assumption of multiple entities, a particular affect held by one of the entities toward the other, and corresponding choices that match that affect.

biodiversity protection – *Protection* refers to the actions taken to preserve the integrity of some valued thing or person, to keep it from being harmed by some threat. This is very similar to Fauconnier & Turner's (2002) analysis of *safe*, which can only be understood within a schema for DANGER. In this schema there is some 'valued thing' that could be harmed by a potential 'threat' to that thing. *Protection* assumes the DANGER schema and references the 'preventive action(s)' that keep the 'harm' from being realized. As

Fauconnier & Turner point out, this can only be understood with respect to a counterfactual scenario in which the 'valued thing' is actually harmed by the 'threat'. Finally, 'biodiversity' is easily mapped onto the role of 'valued thing' within the PROTECTION schema. No general semantic relation links the two nouns to paraphrase the compound's meaning, and even if it did, it seems implausible that a nonschematic understanding could arise given the inherently schematic nature of *protection*.

gasoline shortage – Sometimes it is less obvious that a constituent is understood through a schema which organizes our understanding of human behavior. *Shortage* is one such constituent. The SHORTAGE schema includes a 'commodity' which is used for some particular 'purpose', people who would like to be 'users' of that commodity, and an 'amount' of that commodity that is necessary in order for 'users' to complete certain activities or maintain a certain state of affairs corresponding to the 'commodity's purpose'. This is all to say that a shortage is not just any situation where there is less of something than there was before or than there normally is. There can only be a shortage of something based on the particular needs people have for that commodity. *Gasoline shortage* can easily be understood because gasoline is a commodity that people use on a regular basis to carry out day-to-day activities. Again, this is a compound whose meaning is not adequately paraphrased with a relation between the two nouns. It could be paraphrased as 'a shortage of gasoline', but that can only be understood by taking it as a prompt to imagine a scenario where people don't have enough of something in order to accomplish some goal and where gasoline is somehow involved.

There are many other compounds in the COCA sample that can only be understood by using a schema for human activities which is necessary for understanding one of its

constituents. Some of these are *certification program*, *coalition spokesman*, *convention delegates*, *divorce settlement*, *export porcelain*, *group conversation*, *hockey coach*, *inspection team*, *offseason acquisition*, *parenting role*, *rivalry game*, *security lapses*, *shift work*, *stock fraud*, *teaching candidate*, and *time allotment*.

4.3.3 Relations that are inadequate without schemas

Some of the general relations that can reasonably be assumed to motivate compound meanings are inadequate without the help of schemas. This issue has been touched on in Sections 4.3.1 and 4.3.2 but not discussed directly. For many relations, their obviousness as a selection or their potential to lead to a more complete and specific understanding of a compound is dependent on schematic knowledge of some kind. From the human-centered schema view, this is a problem that any general relation would face. For some relations, however, the problems are more obvious and pervasive. This section provides a review of some of the issues for a few such relations.

4.3.3.1 For/Purpose

A large number of compounds of the form XY could be paraphrased with ‘a Y for X’. Often, this is in fact an obvious paraphrase. But what makes this paraphrase obvious for so many compounds is schematic knowledge of one kind or another.

In particular, a Purposive relation is often an adequate paraphrase only given full schematic understanding of the head noun and what its purpose typically is. The modifier must be linked to the head noun schema and it is the appropriateness of this linking that determines the obviousness of the relation. *Bug repellent* for example, refers to something that you use to keep bugs away. The obviousness of this fact is motivated by the REPEL

schema, in which an agent (‘repeller’) does something with a ‘repellent’ to keep an unwanted thing (‘repellee’) away from the ‘repeller’. People typically do not want bugs crawling all over themselves or their things. The term is therefore transparent because of how easily ‘bug’ fills the role of ‘repellee’ within the REPEL schema. It is unclear, therefore, on what basis the For relation would be obvious within the RICE framework as a means of understanding *bug repellent*. Other compounds from the sample for which a Purposive relation is motivated by how well the modifier fits a particular role in the head noun schema are *cancer drug*, *combat boot*, *diabetes medication*, *hernia surgery*, *mathematics classroom*, *party operatives*, *physics lab*, *reservation office*, *school uniform*, *sports shoes*, *stage clothes*, *trash bag*, and *water bowl*.

Other compounds paraphrased with a For/Purpose relation are only transparent given full schematic knowledge of one of the constituents. A *pool table* for example, refers to the table on which pool is played. This is an incredibly obvious fact only if you already know what the game of pool is: that it is a game played on a specialized table with a felt surface on which balls can be struck with cues in order to get them into pockets which are part of the specialized table. All of this knowledge, the schema of POOL, is necessary to make any sense of *pool table*. One does not arrive at a functional understanding of the compound without this knowledge. Similar compounds are *projection screen*, *soup bone*, and *wallpaper paste*. In these instances, it is clear that the compound XY is ‘a Y for X’ because the head noun is a conventionalized part of the modifier’s schema. RICE does not permit reliance on such specific schemas. Other compounds require a little bit more inference but are similarly motivated by particular knowledge of one of the constituents. It is obvious, for instance, that *drought relief* would refer to rain only with schematic knowledge of

RELIEF. Within this schema there is a continued ‘undesired state/sensation’ followed by the positive sensation of ‘relief’ which comes with the ‘cessation of the undesired state/sensation’. ‘Drought’ can easily be mapped onto the role of ‘undesired state/sensation’ because a lack of rain is bad for plants and farmers and creates potential for a public health crisis. Within the RELIEF schema, something has to happen to alleviate the symptoms, problems or conditions being experienced. Schematic knowledge of droughts suggests that rain can do this because it would directly nurture plant life while filling up reservoirs. Other compounds which similarly rely on integrating specific knowledge of the constituents in order for a Purposive understanding to be transparent are *rescue vehicle*, *riot squad*, and *tax relief*.

Finally, there are compounds with Purposive relations that are transparent only because of the salient role that each noun plays in some other schema. They are transparent terms not because one is capable of composing the compound meaning with a generic meaning construction process but because of direct access to known schemas and the roles the nouns play within them. Take *agreement scores* for example. These are calculations of how much agreement there is between multiple raters, often within the context of creating experimental stimuli or making judgments about the results from experiments. Knowledge of this entire context is necessary for making the compound intuitive and transparent. Otherwise, it seems implausible that one could use a generic For relation and infer the specifics of the compound’s meaning. Given all this knowledge, it is also obvious that the paraphrase of ‘a score for agreement’ is a short circuited version of ‘a score for measuring agreement between raters’. Other compounds from the sample that are similarly reliant on specific schemas in which each noun participates include *access number* (a number for

getting access to some digital information or service), *hall pass* (a pass for students to use to indicate that they have the teacher's permission to be in the hall), *rights fees* (fees for getting rights to using intellectual property in some particular way), *safety belt* (a belt for maintaining the safety of passengers in an automobile), *wrinkle cream* (cream for preventing or getting rid of wrinkles in one's skin).

4.3.3.2 Made Of

Many NN compounds express a Made Of relation between the nouns. Typically it is an instance of the head noun which is made of the modifying noun in some way. Though it might seem like schematic knowledge of the head noun is not required to understand such relations, such schematic knowledge does in fact explain why such compounds are so obvious. In some cases it explains potential ambiguity or motivates understanding of the particular way in which the compound refers to an instance of the head noun made of the modifying noun. Consider *wire brush* for instance. Clearly, the entire brush is not made of wire. It is one part in particular, the bristle, which is made of wire. This is clear because of the structural similarity between wires and bristles and the lack of structural similarity between wires and other parts of brushes. What this example highlights is that taking a general Made Of or Made With relation and applying it to *wire brush* would not reliably yield the obvious understanding without holistic knowledge of brushes, their component parts, their functions, and what they are typically made of.

A similar example is *leather seat*. Without schematic knowledge of chairs, benches and other things that could be called "seats", it would not be obvious that a common variable among these things is the material that comprises their surface. That is to say, we know that some seats have a frame made of a more rigid material like wood, and that around that

frame is stuffing and some sort of upholstery material or fabric. Leather is one such material. Without schematic knowledge of the various things called "seats", there is nothing within the RICE framework to keep one from inferring that *leather seat* refers to chairs which are constructed entirely out of leather. What's more, the obviousness of Made Of relations is motivated by knowledge of one of the noun's function, what its component parts are typically made of, why they are made of those things, and to what degree the other noun is similar to materials or capable of playing a similar function. Compounds from the sample whose transparency seems dependent on such schematic knowledge are *bronze bust*, *flannel trousers*, *iron key*, *limestone floor*, *metal cart*, *metal staircase*, *plastic plate*, *silk dress*, *suede jacket*, *wood flooring*, *wool stockings*, and *wool suit*.

4.3.3.3 Has/Part-Whole

Another common relation between nouns in compounds which is notably difficult to defend without schemas is the Part-Whole relation, described as a Has relation in the CARIN and RICE frameworks. There are many examples from the COCA sample where a Part-Whole relation is the obvious paraphrase for the compound's meaning. But upon closer inspection, it is only with holistic structural knowledge of the whole referred to within the compound that this relation is obvious. Take *flower stalk* for example. Obviously, a stalk is a part of a flower and a *flower stalk* is a stalk that a flower has. But how could one know this without holistic understanding of the structure of flowers? Or more generally, how could one know this without structural knowledge of plants? Such holistic knowledge represents the various parts of something and how they relate to each other and to the whole. Even for a novel compound (and this is NOT in the COCA sample) such as *chair branch*, interpreting it as a branch-like appendage that extends from a chair

would require applying one's holistic knowledge of trees and how branches fit in with their overall configuration and then analogously mapping this knowledge onto the structure of a chair. It strains credulity to argue that this is somehow nonschematic. Other compounds from the COCA sample where a part-whole relation is obvious but only given the holistic structured knowledge of the whole include *apron pocket*, *building entrance*, *chamomile tea*, *dresser drawer*, *Jets quarterback*, *knife point*, *lake surface*, *lettuce leaf*, *mouse brain*, *oak branch*, *office complex*, *oregano leaves*, *pumpkin cheesecake*, *quiz questions*, *tomato salsa*, and *tree branch*.

4.3.3.4 About/Topic

The problems with the Topic relation as a nonschematic relation were touched on in Section 2.3.1. To review, only certain kinds of things can be said to have a topic. Typically, it is a form of communication in which some sort of information is shared that is said to have a topic. The topic is a general area of knowledge or theme which the information pertains to. Chairs and cars aren't typically thought of as having topics because they aren't typically used as a means of communication. To know whether something can be construed as having a topic and what sort of topics are plausible requires knowing what communicative schemas it participates in. Topic is clearly an appropriate relation for understanding *compensation committee* because committees are often formed for investigating or making decisions about particular issues, especially regarding institutional policy. Compensation is a complex issue for organizations and so it is a plausible topic for a committee to discuss, investigate, or make decisions about. Knowledge of what committees do, the importance of their topical focus, and the likelihood of their communicating their findings on that topic in the form of a recommendation are all part of

what makes the Topic relation obvious. RICE simply has no way of explaining how the About relation is competently and reliably used without recourse to schemas. Why is it obvious? On what basis would you choose it or elaborate from a vague meaning to one that is specific enough to be considered functional? Other compounds from the sample for which a topic relation is similarly schematically motivated are *crime novel*, *diet advice*, *love poetry*, *math question*, *nativity play*, *odor complaints*, *philosophy class*, *sleep research*, *stock report*, *styling tip*, and *trade position*.

4.3.4 Inadequacy of relational paraphrase

The final and most serious problem for RICE in accounting for conventionalized NN compound meaning is the significant number of compounds which are not well paraphrased in terms of a relation between the nouns. Within RICE, the comprehension process is assumed to always be guided by such a relation. From a human-centered schema perspective, this need not be the case. A compound could be created and assumed to be easily understood because each of the nouns plays a salient role within a schema in which they co-occur. Alternatively, the meaning of a compound could be structured by the schema of one of the nouns while the other noun plays a role in that overall schema.

It is helpful to remember that there is a difference between a paraphrase which relates two nouns together semantically and a paraphrase which structurally consists of the two nouns with an intervening preposition. For example, many of the compounds to be discussed in this section could be paraphrased as ‘a Y of X’ (given the XY compound format). As should be obvious and as the various examples discussed will illustrate, “of” does not specify any particular semantic relation. The analysis that follows makes it clear that ‘Noun of Noun’ constructions, like NN compounds, serve as a prompt to link the nouns

schematically in some way. Some of the compounds discussed could be paraphrased with prepositions such as *in*, *on*, or *to*. However, the appropriateness of such prepositions seems motivated by constructional happenstance of the head noun rather than any consistent semantic contribution of the preposition.

4.3.4.1 Nouns relating to an external schema

Many compounds in the COCA sample are perfectly transparent only given holistic knowledge of a schema in which both nouns occur.

hand rail – There appears to be no simple relation between nouns that adequately paraphrases the meaning of *hand rail*. The most tempting option would be 'rail for hand', but this is unsatisfactory for a number of reasons. Suppose someone does not know what a hand rail is. Their generic knowledge of hands and rails would not enable them to understand the compound because the function of hand rails does not extend from the intended function or purpose of rails in general. Rails more generally are simply long extensions of some material, often lining something lengthwise such as the rails of a railway. *A rail for one's hands* is only meaningful to someone who already knows what a hand rail is. But given more complete knowledge of the situations in which hand rails occur, it is fairly obvious why the term *hand rail* is used. Like other things called rails, the referent is an extension of a solid material which lines something. Given their function – to keep people from falling down – the role of one's hands is quite salient because it is by grasping the rail with a hand that one avoids falling down. Of course, within the HAND RAIL schema there is a relation between 'hand' and 'rail': it is a rail that one grasps with one's hand. But this is highly specific and only meaningful given knowledge of the general point of grasping the rail, which is to avoid falling down. Reliance on such specific

knowledge cannot be squared with RICE's assumption of competition, selection, and elaboration of general semantic relations.

drug suspect – There appears to be no general relation which could paraphrase the meaning of *drug suspect*. It is not generally 'a suspect who does drugs', or 'a suspect who has drugs'. Such paraphrases are inadequate because they disallow the ambiguity as to what exactly the suspect did with drugs. Additionally, these paraphrases are odd because one is not a suspect independent of some activity. One can only be a suspect within the schema of criminal investigation. We know that *drug suspect* probably refers to a person who is suspected by the police of having done something illegal with drugs such as sell, manufacture, or possess them. But this sort of inference is made possible only by schematic knowledge that relates roles of outlawed activity ('crime'), the doer of such activity ('criminal'), and police officers whose job it is to provide evidence that particular people committed particular crimes ('detectives'). Given that knowledge, the term *drug suspect* is entirely clear. The constituent 'drug' is salient because we know that to be a suspect one has to be suspected of a particular crime by the police and that certain activities are outlawed for certain drugs.

stage mother – This compound refers to the mother of a child actor. 'Stage' is thus a salient metonymical stand-in for theatre or acting. The relevance of the term *stage mother* comes in part from the fact that the child is not independent and could not pursue acting without the mother's (or some other adult's) active participation. The term is thus analogous to *soccer mom*. If one has knowledge of the acting world and the lives of child actors and the roles their mothers often play, the compound is highly intuitive. But it does not express a relation between a mother and theatre directly. It requires schematic

knowledge of the dependence of children on their parents and perhaps of the perceived pushiness of parents who have their children pursue acting professionally. None of this could be understood through a general relation between the constituents, yet the referential meaning and relevance of the term is highly accessible.

Additional compounds from the sample whose meanings are not adequately paraphrased by a relation between the constituent nouns and for which an adequate understanding is reliant on a schema in which the two nouns participate are *attitude questions*, *championship ring*, *curriculum goals*, *graph theory*, *nose tackle*, *phone logs*, *radio image*, *research attention*, *size limit*, *tax levy*, and *wind farm*.

4.3.4.2 Nominalized verbs imply external relations

Another major group of NN compounds which are not readily paraphrased by a general semantic relation linking the two nouns are those where the head noun is a nominalized form of a verb. In such cases, the structure of the compound concept is supplied by schematic information invoked by the verb root. This schematic information includes an implied argument, often a human agent, whose relationship to the other noun is specifically expressed by the verb root in the head noun. Typically, the modifying noun fills a more patient-like role within the verb's schema.

anger management – Making sense of *anger management* is made possible not by some general semantic relation but by specific knowledge of what managing something entails. Within the schema for MANAGE, there are the roles of 'manager' and 'managee'. The 'manager' is a (typically) human agent who directly or indirectly controls the 'managee'. The goal of the 'manager' is to maintain a state of affairs where the 'managee's actions or state (or the effects resulting from the 'managee's actions or state) are not

problematic. ‘Anger’ can easily fill the role of ‘managee’. Without awareness of one’s anger and the effects it has on one’s behavior, it can lead to erratic or abusive actions. To avoid harming others and damaging relationships, it is important to manage one’s anger by monitoring one’s emotional response in various situations, ensuring that anger is kept within reasonable bounds, and resisting impulses to lash out at others as a result of anger. *Anger management* is thus understood by setting up a generic MANAGE schema, mapping ‘anger’ onto the role of ‘managee’, and simulating the ways in which one chooses to respond to one’s own anger in a constructive manner. The nominalizer *–ment* prompts us to focus on the general long term process of this schema. *Anger management* is a clear case of schema-dependent meaning which cannot be handled by RICE’s assumption that compounds are understood through a general semantic relation linking the two nouns.

geometry teacher – In the case of *geometry teacher*, a paraphrase which semantically links the two nouns is available. The problem for RICE is that this relationship is in no way generic: a geometry teacher is ‘a teacher who teaches geometry’. As the redundancy implies, the compound’s meaning is dependent on our understanding of the schema for TEACH. Teaching events involve two main parties, ‘teacher’ and ‘student(s)’. Additionally, there is a general ‘subject’ which the ‘teacher’ organizes a variety of lessons and assignments around in order for the ‘students’ to gain knowledge and skills pertaining to that ‘subject’. Any real understanding of *geometry teacher* requires an understanding of this entire framework and mapping ‘geometry’ onto ‘subject’ within the TEACH schema. In contrast with the assumptions of RICE, no relation motivated gist interpretation could form the basis of a subsequently more detailed understanding of *geometry teacher* without such a schema.

probability assessment – Like many of the compounds discussed in this chapter, *probability assessment* is best paraphrased in the 'Y of X' format: a probability assessment is 'an assessment of probability'. As in the other instances discussed this is a strong indication of a schema-dependent compound meaning. Within the ASSESS schema, an agent (the 'assessor') examines a thing, person, or situation (the 'assessee') with the goal of providing a 'value judgment' which provides information about the quality of the 'assessee' along some dimension or a measurement of some aspect of the 'assessee'. *Assessment* is a nominalized form of *assess* which is ambiguous in its potential ability to refer either to the general process of assessing or the 'value judgment' resulting from an instance of assessing something. In the case of *probability assessment*, it is clear that 'probability' is likely meant to be understood as the 'value judgment' resulting from an assessment because probabilities are a type of quantitative measure. In practice this is the case. Most of the instances of *probability assessment* in COCA appear to occur within the discursive domain of risk management. Here a probability is calculated for particular outcomes based on potential decisions. Thus 'probability' is a 'value judgment' in the ASSESS schema and refers to the likelihood of the events which should be avoided. The 'assessee' is the set of choices which would potentially influence the risk (or probability) of certain undesired outcomes.

Interestingly, *probability assessment* is potentially ambiguous. Under the right circumstances 'probability' could fill the role of 'assessee'. Someone could provide a review of the accuracies of different rain forecasting methods, determining how reliable they are at estimating the odds of rain. This reliability measure would be the 'value judgment' and the probabilities that the forecasting methods produce would be the

'assessee'. Only a schema approach in which these different roles and their relations are assumed can explain the potential for this ambiguity, especially given the fact that the paraphrase 'assessment of probability' applies equally to the different types of meaning. Schemas also explain why interpretations linking 'probability' to 'assessee' is generally unlikely and why it would need to be instantiated by a particular context in which the quality of probabilities are being assessed. Again, there is not a simple semantic relation that can link 'probability' and 'assessment' to provide an adequate paraphrase of the compound's meaning. This is because understanding any part of the ASSESS schema requires understanding the various roles and how they are specifically related to each other.

There are many more compounds from the COCA sample with nominalized verbs for head nouns which are similarly problematic for RICE. What all of those listed here share with the three just discussed is that the head noun's schema supplies a specific role linking some argument to the modifying noun: *calcium intake*, *calcium loss*, *campaign contributor*, *document examiner*, *equipment maker*, *family influence*, *farm operators*, *feature debut*, *grain harvest*, *heroin dealer*, *jazz singer*, *pain perception*, *pet ownership*, *slum clearance*, *speech writer*, *sperm production*, and *spouse abuse*.

4.3.4.3 One noun plays a role in the other noun's schema

Another group of compounds commonly occurring in the sample are those whose meanings are dependent on one's ability to link one of the nouns to a particular role within the other noun's schema. One needs holistic knowledge of the schema supplying noun to make sense of the compound. The relations which structure the compound meaning are specific relations supplied by that schema rather than some general level relation such as Location or Cause.

housing industry – Attempts to paraphrase *housing industry* by semantically linking the two nouns produce decidedly awkward results. 'Industry about housing' seems odd because industries aren't forms of communication. Though the housing industry is a collection of economic activity that centers around housing, housing isn't really the topic of housing industry. Additionally 'industry for housing' is a little forced because it's not an industry that exists independent of housing. The industry itself has instead a symbiotic relationship to housing: the need for housing produces the markets for contractors, carpenters, architects, and lenders which facilitate the construction of new housing. *Housing industry* is thus better understood in terms of holistic knowledge of what an industry is. It is a reference to all the various business ventures that depend on and enable the production of or sales of some particular thing. 'Housing' can fill that particular role within the INDUSTRY schema. Other compounds from the sample which similarly link a modifying noun onto specific roles within schemas for economic activity are *aluminum industry*, *drug industry*, *education market*, *marijuana business*, *media business*, *timber company*, and *transport company*.

memory researcher – This compound exemplifies a category of compounds where the modifier fills the topic role in many of the other noun's subschemas. It is this collection of subschemas that structures our understanding of the head noun and therefore, the compound concept. It would be odd, for example, to describe the meaning of *memory researcher* as 'a researcher about memory'. As in the case of *geometry teacher*, we can redundantly but more accurately say that a memory researcher is 'a researcher who researches memory'. Understanding what this means requires knowledge of the sorts of things that researchers generally do. 'Memory' can play topic roles within the subschemas

of RESEARCH only because we know that researchers: ask and attempt to answer questions about particular topics; share their ideas about these topics in journals and at conferences; often teach courses about their area of expertise. This sort of relationship between modifier and the head noun's various subschemas is particularly prevalent in compounds pertaining to fields of expertise. Other examples from the sample include *journalism professional*, *media professional*, *sports journalist*, and *writing career*.

articulation test – Other compounds from the sample whose meanings are motivated by linking one constituent onto a role in the other noun's schema do not adhere to a particular pattern as *housing industry* and *memory researcher* do. In this way they highlight the importance of schemas even more so because understanding the compound is contingent on understanding the idiosyncratic structure of one or more of the noun concepts. *Articulation test*, for example, is a term in speech language pathology for tests of a patient's ability to produce particular speech sounds. The appropriateness of the term and accessibility of its meaning stem from structured knowledge of tests and the ability of 'articulation' to play a particular role. The TEST schema includes an 'administrator' who decides the 'purpose' and 'content' of the test and is likely responsible for assessing 'test takers' outcomes. Tests are designed to assess 'test takers' knowledge about a 'topic' or ability to use a particular 'skill'. Articulation of speech sounds is one such measurable skill because it is an action people do and for which one can reasonably be understood to succeed or fail. 'Articulation' is therefore easily mapped onto the role of 'skill' within the TEST schema. The best simple paraphrase of *articulation test* is 'test of articulation' and this of course suggests no general semantic relation with which the two nouns should be linked. Other compounds from the sample whose meanings rely on our ease of mapping one

constituent onto a role in the other noun's schema and for which there is no simple paraphrase based on a general semantic relation include: *alcohol dependency*, *admissions official*, *coal reserves*, *committee chairwoman*, *high-school girl*, *import tax*, *land degradation*, *news junkie*, *oxygen supply*, *population fluctuations*, and *sustainability indicators*.

4.4 Chapter summary

Analysis of lexicalized NN compounds revealed that theories which deny a role for schemas such as CARIN (Gagné & Shoben 1997) or RICE (Spalding et al. 2010; Gagné & Spalding 2013) have comparatively less explanatory power than the human-centered schema view. This explanatory gap extends from the fact that any relation that describes the meaning between constituents of a NN compound can be represented schematically since relations are precisely what schemas encode. Explanatory problems resulting from the rejection of schemas include i) arbitrary selection of a single relation ii) the frame-semantic nature of constituent meaning iii) the inherently schematic nature of various semantic relations iv) the inability to elaborate a general meaning to a more specific and functional one without schemas v) the apparent lack of a general semantic relation which can provide an adequate paraphrase for many compounds' meanings. The NN compounds discussed and listed in this chapter comprise more than a fourth of the sample (212 out of 724). The pervasiveness of these problems and the fact that they were demonstrated in a random sample of NN compounds confirms the seriousness of CARIN and RICE's explanatory problems.

One potential criticism of the approach taken in this chapter is that the human-centered view is too flexible and informal. Admittedly, the human-centered approach operationalizes schemas less formally than the 'slots and fillers' approach assumed by Murphy (1988, 1990), Wisniewski & Gentner (1991), and Wisniewski (1996, 1997). But this makes it more appropriate as a tool for assessing whether schemas do or do not play a role in understanding NN compounds. The human-centered approach puts more value in the explanatory insights shared by various schema theories than it does formal application of these insights within a narrow framework. Theories which claim not to be reliant on schemas need to demonstrate how the transparency of lexicalized compounds and the disambiguation of novel ones can arise without knowledge of the typical structure of various events and situations, which includes knowledge of typical roles and relations between them.

To this point one could argue that the method of qualitative analysis taken in this chapter does not provide strong evidence for the psychological validity of the human-centered schema view. Though it is true that using a psychological theory to explain the meanings of naturally occurring compounds involves reverse engineering, this merely highlights that qualitative analysis is insufficient for demonstrating a theory's validity. It is still necessary, however, because even with predictive success in the laboratory, any theory that does not explain the naturally occurring phenomenon it was designed to account for must be revised.

The sort of knowledge which motivates the semantic transparency of lexicalized NN compounds is often schematic. This descriptive fact is as empirically justified as the fact that many compounds can be paraphrased with a semantic relation linking the two nouns.

Any psychological theory of NN compounds must accommodate both of these facts. In this respect, the human-centered schema view succeeds where the nonschematic approach of CARIN and RICE fails.

Chapter 5

Experimental evidence for schemas

Proponents of schema-based accounts of noun-noun compound comprehension have provided a variety of experimental tests of their theories (Murphy 1990; Wisniewski & Gentner 1991; Gerrig & Murphy 1992; Ryder 1994; Wisniewski 1996; Wisniewski & Love 1998). Missing from this body of work is an attempt to produce different conditions in which subjects encounter or create schemas that bias them toward specific interpretations of novel NN compounds. Successfully doing so would i) motivate a dynamic, experientially grounded view of schemas ii) provide evidence for their role in understanding a novel NN compound iii) validate the basic tenet of conceptual blending that concepts are formed by mapping entities and features onto roles in schemas and that this happens on the fly during language comprehension. Such findings would support the human-centered schema view while posing a great challenge to theories which claim that NN compound comprehension is not guided by schemas. The experiments reported in this chapter succeed on these fronts and specifically provide results which are difficult for CARIN (Gagné & Shoben 1997) and RICE (Spalding et al. 2010) to handle. Because these theories posit that a NN compound is interpreted on the basis of a single semantic relation, they cannot explain why the experiments reported here succeeded in biasing subjects toward particular interpretations of various compounds which are consistent with a

particular abstract schema but which span various semantic relations. The experimental results discussed in this chapter also run counter to the more narrowly delimited role of schemas in the schema modification view (Murphy 1988; 1990), in which a schema is defined as the world knowledge of the head-noun represented in terms of slots and fillers.

The general reasoning behind all experiments discussed in this chapter is the same. In each one subjects in different conditions read slightly different versions of the same passage and then interpret one or more compounds of the form Animal-Noun. The passages describe two characters, typically depicting a scene involving them, and differ most notably in a one or two word difference in the opening sentence. This difference determines whether subjects read about animal characters or human characters. It is expected that subjects who read a version in which the characters are animals are more likely to interpret the target compound in an anthropomorphic way, e.g., *crab shirt* as 'a shirt that a crab wears'. The human-centered view of schemas makes this prediction because understanding the animal-centered passages would entail mapping animals onto the role typically filled by humans in a variety of schemas. The construction of various anthropomorphic mappings motivates an abstract schema, in which animals are linked to the human role in schemas generally, that is then more likely to be utilized when interpreting the target Animal-Noun compounds.

5.1 Experiments 1-3

In this section, three similarly designed experiments are discussed which provide initial support for a role of schemas and conceptual blending in the comprehension of NN compounds.

5.1.1 Experiment 1

In Experiment 1, subjects read a description of two characters and on the following page saw the compound *crab shirt* for which they provided the first interpretation that came to mind. Each subject was randomly assigned to one of three conditions: Human, Penguin, and Lobster. Those in the Penguin and Lobster conditions read passages that were identical to the passage in the Human condition except for a few key words. Most importantly, those passages began "Michael and Alice are two penguins/lobsters who…" rather than "Michael and Alice are good friends who…". If higher level schemas and mapping of entities onto roles in those schemas play a role in understanding novel NN compounds, we would expect an increasing rate of anthropomorphic interpretations (*crab shirt* as 'a shirt worn by a crab') going from Human to Penguin to Lobster conditions. This prediction follows from the idea that i) understanding the Penguin or Lobster condition passages involves mapping those animals onto the role typically assumed by humans for various schemas, such as shopping and working and that ii) this mapping produces schemas at multiple levels of specificity which could potentially be employed to interpret subsequently encountered ambiguous language.

To illustrate idea 2, reading the passage in the Lobster condition would produce both a general ANTHROPOMORPHIC schema, in which disbelief is suspended and an animal is allowed to do uniquely human things, and a specific ANTHROPOMORPHIC LOBSTER schema in which lobsters in particular partake in human activities. Other schemas, which could be thought of as intermediate between these two levels would also emerge: sea creatures doing human things, crustaceans doing human things, red animals doing human things, etc. The predicted rates of anthropomorphic interpretation stem from the fact that

humans, penguins, and lobsters respectively instantiate an increasing number of classes which crabs also instantiate. Subjects in the Lobster condition encountered *crab shirt* having just created schemas that strongly motivate the mapping of 'crab' onto the role of 'wearer' in a SHIRT schema, while those in the Human condition have created no such schemas. Owing to the fact that penguins are animals but resemble crabs less than lobsters do, those in the Penguin condition represent an intermediary level of priming.

5.1.1.1 Subjects

89 subjects from two introductory linguistics courses at Rice University participated in the study for extra credit. All but 8 were native speakers of English. Age and Gender were recorded for subjects from just one of the courses. Of these 41 subjects, 21 were female, 20 male and all but three were native speakers of English. Subjects were randomly assigned to three groups, which correspond to the Species conditions Human (N=28), Penguin (N=29), and Lobster (N=32).

5.1.1.2 Materials

Three different reading passages were created, one for each of the three groups to which subjects were assigned. The passages differed in only a few words and were around 180 words long each. The passages consisted of a description of two characters, Michael and Alice. For the Human group, the first sentence read "Michael and Alice are good friends who have known each other since they were little". The Penguin group's reading differed from the Human group's only in this sentence, where in place of "good friends" it read "two penguins". The reading passage for the Lobster group was similarly changed to "two lobsters". The only other difference between groups is that later on the Lobster group's

passage states that Michael and Alice work “in” rather than “near” the bay. The reading passages for Experiment 1 are found in Appendix B.

5.1.1.3 Design and procedure

Participants were e-mailed a link to their group’s respective task and were instructed to complete the task within a week. On the landing page from the link, they were informed that the task would consist of reading a passage, clicking “Next” when finished, and on the following page, describing the first interpretation that comes to mind for a “novel pair of nouns”. They were given the example of *car fruit* as such a pair, which one could describe as ‘a fruit that is eaten in a car’ or ‘a fruit sold out of a car’ or whatever comes to mind. It was also explained that the two nouns would refer to one thing and so they should not define the nouns separately. The priming passage followed the instructions and this passage was followed by the compound *crab shirt*, which was presented in all caps. Subjects for whom demographic information was collected (Age and Gender) answered the relevant questions after completing the experimental task.

5.1.1.4 Results and discussion

Interpretations were analyzed and coded by the author in random order without knowledge of the conditions in which they were produced. They were coded “Anthropomorphic” for the variable Interpretation Type if they could be paraphrased as ‘a shirt worn by a crab’, and “non-Anthropomorphic” otherwise. Examples of Anthropomorphic interpretations are ‘a shirt made for crabs’, ‘a shirt that a crab wears’, and ‘a shirt made for the body type of a crab’. Examples of non-Anthropomorphic interpretations are ‘a shirt with a picture of a crab on it’, ‘a shirt you would wear to the beach’, and ‘a shirt with crabs on it’. The

predicted relative rates of Anthropomorphic interpretation were confirmed, with Human, Penguin, and Lobster condition participants providing such interpretations at rates of 0% (0/28), 14% (4/29), and 34% (11/32) respectively. Though logistic regression cannot provide meaningful values when there is zero occurrence of a categorical outcome for one or more levels of a factor, a chi-square test of independence between Interpretation Type and Species allows us to reject the null hypothesis that they are independent [$X^2(2)=10.548$, $p < 0.01$]. These results provided initial evidence that higher level conceptual schemas play a role in comprehending novel NN compounds. For more confidence in this finding, however, one would want to see the same effect for compounds other than *crab shirt*. Doing so would ensure that the priming effect was not due to some unique elements of people's ideas about crabs or shirts. Thus, the larger number of compounds through which the priming effect can be demonstrated, the stronger the evidence for people's reliance on abstract schemas in comprehending NN compounds.

5.1.2 Experiment 2

The second experiment attempted to extend the results of Experiment 1 to additional compounds of the form Animal-Noun. Doing so would allow us to infer that the results in Experiment 1 are due to something generalizable rather than something special about crabs, lobsters, penguins, shirts, or the particular reading passage used.

5.1.2.1 Subjects

94 subjects from an introductory linguistics course at Rice University participated in the experiment for extra credit. Responses for four subjects were thrown out because at least

one of their responses to experimental items was too vague to be coded, leaving 90 subjects (33 male, 57 female). Of these 90 participants, 79 reported being native speakers of English

5.1.2.2 Materials

Materials were similar to those in Experiment 1 in that each item consisted of a pairing of a passage and a compound of the form Animal-Noun. The target compounds used in Experiment 2 were *fish pencil*, *goat barbecue*, *bear gun*, and *crab shirt*. For each target compound, two versions of a priming passage were created: a Human condition and an Animal condition. As in Experiment 1, the differences between Species conditions consisted of minimal lexical contrasts. In this case, the Animal condition passages contain characters that are of the species named in the target compound. *Crab shirt* was included as a baseline to compare to Experiment 1. There was an additional filler item in which the compound to be interpreted featured no animal. The complete materials for Experiment 2 are found in Appendix C.

5.1.2.3 Design and procedure

Each subject saw two experimental items, each consisting of a reading passage followed by a compound of the form Animal-Noun. There was additionally a filler item between the two experimental items. The experimental items were presented in two Species conditions, Animal and Human. In the Animal condition, the characters described were of the species named in the compound to be interpreted. Each subject saw one item in each condition. Item Order and Species order were counterbalanced across subjects resulting in 8 blocks. Experimental and filler compounds were presented in all caps.

Participants were e-mailed a link to their experimental block and were instructed to complete the task online within five days. Instructions were similar to those in Experiment 1 except that subjects were told they would encounter 2 to 5 items and were informed that at the end of the experiment there would be a reading comprehension question so they should read carefully enough to be able to answer it (this question related to the filler passage). Additionally, there was a practice item, which like the filler item, did not involve an animal. After the practice item, subjects were given the choice of going back to the instructions if they felt they did not understand the task or moving on to begin the experiment. After completing the experimental tasks and comprehension question, subjects answered demographic questions on the final page.

5.1.2.4 Results and discussion

Responses were again coded by the author. Responses to *crab shirt* were coded "Anthropomorphic" for the variable Interpretation Type if they described a shirt worn by a crab and "non-Anthropomorphic" otherwise. Paraphrases of the target interpretations for other items were: for *goat barbecue* 'a barbecue hosted by goats'; for *fish pencil* 'a pencil used by a fish'; and for *bear gun*, 'a gun used by a bear'. All items but *bear gun* showed the expected pattern of higher anthropomorphic rates in the Animal condition than the Human condition (see Table 5.1). Anthropomorphic rates for *crab shirt* in the Human and Animal conditions (0% and 36%) were similar to those found in the Human and Lobster conditions in Experiment 1. A logistic regression model with Interpretation Type (Anthropomorphic = True, non-Anthropomorphic = False) as the response variable was created using the step() and glm() functions in R (R Core Team 2016). The following nuisance variables were used as controls: Gender, academic Major (Cognitive Science,

Psychology and Linguistics were all coded as "CogSci" and all others as "Other"), Semesters of college completed, Age, and whether a subject identified as a Native Speaker of English. When controlling for these nuisance variables, Species proved to be a reliable predictor of Interpretation Type, with the Animal condition reliably resulting in more anthropomorphic interpretations (β = 1.0880, SE = 0.4156, $p < 0.01$). Though Gender: Male was included in the final model (β = 0.7132, SE = 0.3944, p = 0.07), neither it nor any of the other nuisance variables were significant predictors of Interpretation Type.

CRAB SHIRT (N=43)		*GOAT BARBECUE* (N=44)	
Human	Animal	Human	Animal
0%	36%	5%	39%
FISH PENCIL (N=47)		*BEAR GUN* (N=46)	
Human	Animal	Human	Animal
13%	25%	24%	5%

Table 5.1 Anthropomorphic interpretation rate by Item and Species in Experiment 2.

PREDICTOR	COEFFICIENT	STANDARD ERROR	*Z*	*P*
Intercept	-2.3880	0.3909	-6.109	1e-09
Species: Animal	1.0880	0.4156	2.618	0.00884
Gender: Male	0.7132	0.3944	1.808	0.07056

Table 5.2 Logistic regression model predicting likelihood of Anthropomorphic interpretation in Experiment 2.

Though the overall results are consistent with the results in Experiment 1, the anomalous results for *bear gun* mean that the observed effect from Experiment 1 was successfully extended to only two new items. Upon closer inspection, however, an inconsistency was noticed between the passage paired with *bear gun* and the other passages. In all passages, there is some description of characters' actions. The passage for *bear gun* was unique in that virtually the entire passage consisted of dialogue between the two characters. It is within this dialogue that we learn of one character's previous family vacation to Colorado and their activities therein. These are the activities, aside from the characters' ability to speak, that makes the passage anthropomorphic in the Animal condition. Because the passage centers around a quotidian chitchat event, comprehension of these events serves to help understand the interaction between the characters. The reported and hierarchically lower nature of these events contrasts with events in passages for other items which describe characters' present or typical activities. It is possible that this led to a less rich construction of anthropomorphic schemas than occurred for other items and that this is why the expected relative rate of anthropomorphic interpretations between Species conditions did not obtain. Additionally, because the dialogue for the *bear gun* passage could be described as chitchatty, readers might read it less carefully since a careful understanding of the details of chitchat is not necessary to get a sense of the social meaning of the bears' interaction.

5.1.3 Experiment 3

The possibility that inconsistency in stimuli resulted in the inconsistent interpretation patterns across items motivates further attempts to bias subjects toward interpreting *bear gun* as 'a gun used by a bear'. This was the goal of Experiment 3.

5.1.3.1 Subjects

25 subjects were recruited from intro and intermediate level linguistics classes. Responses for one subject were removed from analysis because of vagueness. Of the remaining 24 subjects, 11 were male, 13 female, and 21 identified as native speakers of English.

5.1.3.2 Materials

The materials were created from the materials in Experiment 2. Two experimental items were used, *bear gun* and *crab shirt*. *Crab shirt* had the same reading passage as in Experiment 2. In the present experiment *bear gun* was preceded by the passage for *pencil fish* in Experiment 2. The word "fish" was replaced with "bear" and the word "crawfish" was replaced with "fish". At the end where in the passage for *fish pencil* it says "Watching strangers swim by", this language was replaced with "Watching strangers saunter by". All materials for Experiment 3 are found in Appendix D.

5.1.3.3 Design and procedure

The procedure was identical to the procedure in Experiment 2. Subjects were e-mailed a link to their respective experimental block and were again instructed to complete the task within five days. As in Experiment 2, subjects saw an experimental item, a filler, and then another experimental item, with the condition order counterbalanced between two groups. Because of the small number of subjects, only two blocks were used (order of item presentation was not counterbalanced). Both were of the form *bear gun* / filler / *crab shirt*. They differed in which experimental item was which Species condition.

5.1.3.4 Results and discussion

Responses were coded by the author and the same criteria for coding responses "Anthropormorphic" or "non-Anthropomorphic" from Experiment 2 were used in Experiment 3. This time, the predicted interpretation patterns were confirmed for both items. For *bear gun*, 7 of the 12 observations in the Animal condition were Anthropomorphic while just 2 of 12 in the Human condition were. Similarly for *crab shirt*, 4 out of 12 interpretations were Anthropomorphic in the Animal condition while 0 of 12 were in the Human condition. Using glm and step functions in R, logistic regression predicting interpretation type ("Anthropomorphic" = True, "non-Anthropomorphic" = False) showed a positive main effect of Animal condition (β = 2.5268, SE = 0.9218, p < 0.01) and a negative effect of Age (β = -0.8882, SE = 0.4365, p < 0.05). Other nuisance variables used as controls were Gender, whether subjects identify as Native Speaker of English, Semesters of college completed, and academic Major (again, coding Cognitive Science, Psychology, and Linguistics as "CogSci" and all other responses as "None"). None of these were significant predictors of interpretation type. The complete resulting model is found in Table 5.3.

5.1.4 Summary

Three experiments tested the idea that conceptual schemas play a role in the comprehension of novel NN compounds. Between conditions, subjects read passages that differed in only a few key words. These differences resulted in subjects in Animal conditions reading an anthropomorphic version of the same "normal" description of characters read by those in Human conditions. The purpose of this design was to create conditions in which some sub-

PREDICTOR	COEFFICIENT	STANDARD ERROR	*Z*	*p*
Intercept	15.2149	8.5470	1.780	0.07505
Species: Animal	2.5268	0.9218	2.741	< 0.01
Age	-0.8882	0.4365	-2.035	< 0.05

Table 5.3 Logistic regression model predicting likelihood of Anthropomorphic interpretation in Experiment 3.

jects construct higher level anthropomorphic schemas in which animals play the roles typically filled by humans while others do not. Those in Animal conditions were more likely to provide anthropomorphic interpretations of subsequent compounds. These results are consistent with a model of NN compound comprehension in which conceptual schemas steer language users toward interpretations that are consistent with those schemas. The results additionally support a view of schemas as dynamic and emergent through experience because the schemas were built on the fly in the process of reading a passage.

Despite the significant effect of Species condition on anthropomorphic interpretation rate, a few questions remain which should temper our claims as to the role of schemas in understanding NN compounds. Though the passages were nearly identical between Species conditions, they weren't absolutely identical. There is a chance that reading and understanding the relevant animal name alone primed subjects in the Animal conditions such that the anthropomorphic interpretations became more competitive. In short, controlling for lexical and semantic priming would enable us to more confidently interpret the results as support for a dynamic, associative view of schemas as well as reliance on them in the interpretation of NN compounds.

5.2 Experiments 4 and 5

This section discusses two experiments which were designed to extend the findings of Experiments 1-3 to even more compounds while providing additional controls for lexical and semantic priming. Though a schema-based approach can explain the varying interpretation rates between Species conditions in Experiments 1-3, it is potentially problematic that subjects in the Human condition did not read or otherwise engage conceptually with the animals in the corresponding Animal conditions. It is possible that the Animal conditions successfully biased subjects toward anthropomorphic interpretations simply because they involved processing a lexical item that was either identical or semantically related to the animal named in the target compound. Given the lack of consensus on the mechanism or time course of compound processing, we should remain open to the possibility that simply having greater access to the animal constituent would somehow make anthropomorphic interpretations more accessible. Similarly, it is possible that the act of thinking about animals affects access to animal concepts in a way that makes integration of those concepts with other concepts more flexible in the context of interpreting novel language.

Two more experiments were designed to address these holes in the design of Experiments 1-3 by incorporating an additional task. In each experiment, approximately half of the subjects are assigned to a definition task in place of a reading task. In the definition task, in place of reading a prime passage before interpreting a compound, subjects define words that occur in the corresponding reading passage. Crucially, differences between Species conditions for a definition task reflect the differences in lexical items between Species conditions for the corresponding reading passage. If the Species conditions have similar effects on definers as they do for readers then it would be

unreasonable to claim that this effect is due to schema construction and subsequent reliance on that schema in the interpretation of a novel noun-noun compound. The dynamic view of schemas, on the other hand, predicts that Species should have no effect on the rates of target interpretations for definers because their task does not involve mapping animals onto human roles in schemas of everyday human activities. Such an interaction between Task and Species would rule out the possibility that differences between Human and Animal condition(s) in Experiments 1-3 were simply due to differences in lexical or semantic access.

5.2.1 Experiment 4

The goal of Experiment 4 was to extend the findings of Experiments 1-3 to additional items while also providing more rigorous controls for lexical and semantic priming. Extension to more items was achieved by having subjects interpret two lists of compounds that included both experimental items (again of the Animal-Noun format) and filler items (featuring no animal). Control for lexical and semantic priming was established by randomly assigning subjects to one of two Tasks: Reading and Defining. The Reading task involved reading passages just as was done Experiments 1-3. The Definition task involved providing simple definitions for words found in the respective Species condition passages that readers encounter. Despite these design changes, the general reasoning remains the same. Subjects who have read anthropomorphic passages are expected to be more likely to provide responses that involve an animal filling the role typically assumed by humans. It is additionally predicted that the effect of Species on the likelihood of anthropomorphic interpretation will be weaker for definers than it is for readers. Accordingly, a significant interaction between Species and Task is predicted. Such results would support a dynamic

view of schemas and their role in understanding NN compounds while ruling out the possibility that the significance of Species on readers is due to lexical or semantic priming.

Experiment 4 also differs from the first three in how we broadly characterize the target interpretations. In the first three experiments, we could justifiably label the target interpretations "Anthropomorphic". Many but not all of the target interpretations in the present experiment could also be described as such (for example *turtle truck* when interpreted as 'a truck that a turtle drives'). However, some were not necessarily anthropomorphic. The target interpretation for *elephant meeting* was 'a meeting of elephants'. Responses that could be considered instances of such an interpretation vary in their degree of "anthropomorphicness". An elephant meeting could be a meeting in which elephants congregate to discuss certain topics (overtly anthropomorphic) or simply a gathering of elephants in the wild (not anthropomorphic). Because understanding *elephant meeting* in each of these ways involves mapping elephants onto the role typically filled by humans, schema-based interpretation processes would be expected to produce higher rates of each in the Animal condition.

One might think that the target interpretations could instead be generalized as Agent-based interpretations but here too, there are exceptions. The target interpretation for one compound in the present experiment, *sheep amusement*, arguably assumes a less agentive role for sheep than would otherwise be likely. One typical nontarget interpretation is something along the lines of 'when sheep do things that are entertaining' while the target interpretation is 'amusement experienced by sheep'. Here, the target interpretation assumes an Experiencer role for the animal rather than an Agent role. Additionally, the target

interpretation is not necessarily more Agent-like as many responses explicitly describe the sheep doing things that are entertaining.

Because a target interpretation is not inherently more anthropomorphic or more Agent-based than a nontarget interpretation, a more general term is needed. For Experiments 4 and 5 I use the term ANTHRO to refer to interpretations where the animal is mapped onto a role typically assumed by humans. This of course includes many instances of anthropomorphic or Agent-based interpretations while providing a broader term for the types of interpretations that the intended schema-based priming is meant to motivate. To be clear, the distinction between Anthro and Anthropomorphic is relevant because of the interpretations prompted by the particular Animal-Noun items used in this experiment. None of the interpretations from Experiments 1-3 coded "non-Anthropomorphic" would be analyzed as "Anthro". All of the interpretations that were consistent with mapping an animal onto a human role would be considered "anthropomorphic" in the everyday sense of the word, so the conceptual distinction between Anthro and anthropomorphic interpretations does not suggest any need to reanalyze results from Experiments 1-3.

5.2.1.1 Norming

A norming task was used to create experimental items of the form Animal-Noun, as well as fillers of the forms Noun-Noun, Noun-Animal, and Animal-Animal. The purpose was to provide semantic variety and to ensure that the compounds to be interpreted could justifiably be considered NN compounds.

186 nouns were used in the construction of compounds, none of which were themselves compound words. The nouns varied along the semantic categories of Event/Activity, Cognition/Emotion, Material, Nature (naturally occurring thing or event other than

animal), Artifact, and Animal. Many of the nouns could of course be categorized in multiple ways (cotton is both a natural plant and a material). To confirm that the words were in fact nouns, each was given a "Nouniness" score based on the distribution of forms that occur across instances of the word in an online lemma search in the Corpus of Contemporary American English (Davies 2008-), henceforth abbreviated as COCA. Base forms and plural forms were considered nouny and all other forms non-nouny. The Nouniness score was the percent of all tokens that were nouny. Words with a Nouniness of 95% or more were kept in the list. Also, only nouns occurring at least 1000 times in COCA were used to ensure that none of them were particularly low frequency.

The list of 140 nouns was duplicated such that each noun occurred twice, and nouns were randomly paired with each other to create 280 compounds. Redundant compounds such as *chair chair* were removed. Each pair of nouns was searched for in COCA and only those which had no occurrences as a compound were kept (if the two constituents occurred consecutively but not as a compound, the occurrence did not disqualify the compound from use in the task). Next, the semantic class of the constituents for each compound was analyzed for those that did not have an animal as a constituent. Each compound was given a score of either 0, 1, or 2 depending on how many of its constituents could be considered an instance of a particular class. This process was completed for the semantic categories mentioned above (Event/Activity, Cognition/Emotion, Material, Nature, Artifact). For each category other than Artifact, compounds were selected that had been given a 1 for the category. 8 such compounds were chosen for Event/Activity, 10 for Cognition/Emotion, 12 for Material, and 16 for Nature. Many of these compounds had an Artifact as one of the constituents. Another 12 compounds were chosen which consisted of two Artifacts.

All compounds of the form Animal-Noun which resulted from the random pairing were analyzed in terms of whether an Anthro interpretation could be readily imagined and whether it seemed like there was also a different real-world plausible meaning available. If a given noun was in the same constituent position for multiple compounds, one of the compounds was removed. Any compound that occurred in COCA was also removed. This process left 16 compounds of the form Animal-Noun. To arrive at 22 such compounds, 6 were manually constructed. As in the other compounds, it was ensured by intuition that an Anthro interpretation was possible and that some real-world interpretation seemed readily available. It was also checked that the 6 compounds did not occur in COCA. If the head noun of a manually constructed compound was not included in the thus far constructed list of fillers, it was substituted for the Nature constituent in one of the compounds in the fillers. This was done for two of the manually constructed compounds.

To complete the list of fillers, 10 compounds of the forms Noun-Animal and Animal-Animal each were created by randomly pairing constituents from the 22 Animal-Noun compounds. None of these occurred in COCA and none of the Noun-Animal compounds were the reverse of any of the Animal-Noun compounds.

This process resulted in 100 total compounds. Each of the four categories (Animal-Noun, Noun-Noun, Noun-Animal, Animal-Animal) were randomly halved to create two balanced lists. Each list was pseudorandomized such that no experimental compounds (Animal-Noun) occurred consecutively. 20 subjects (12 male, 8 female) recruited through Amazon Mechanical Turk completed the norming task for $4. Through this platform, they were provided a link to the experiment. Results for one subject were removed from analysis for failure to follow instructions. Subjects were instructed to provide the first interpretation

that came to mind for each compound. It was emphasized that subjects should provide interpretations rather than descriptions of scenarios in which the compound might be relevant (e.g., *ghost habit* as 'the annoying habit of a ghost that haunts a house, for example its tendency to slam doors' rather than 'a ghost regularly slams doors in the middle of the night'). After the instructions there was a brief practice section. Each compound was presented in the center of the screen in all caps with the two constituents separated by a hyphen. The list order was counter balanced. Between lists the word STOP appeared on the screen in all caps and subjects were instructed to get up and stretch or take a brief break if they needed to.

Responses to each experimental compound were analyzed and coded "Anthro" or "non-Anthro". Most compounds received no Anthro responses. Table 5.4 shows the number of interpretations coded Anthro for each experimental compound that received at least 1 such response.

COMPOUND	TOTAL NUMBER OF ANTHRO RESPONSES
crab outrage	4
elephant meeting	8
frog television	2
hawk hat	1
lizard game	2
squirrel bottle	3
shark razor	1
sheep amusement	4
wolf pencil	2

Table 5.4 Number of responses coded Anthro for each item in the Experiment 4 norming task that received at least one such response.

One of the compounds which received no responses coded Anthro, *turtle truck*, had a number of responses that could be considered "almost" Anthro. These could be paraphrased as 'a truck that transports turtles'. Though the prototypically human relation to trucks is that of driver, it is also true that people are transported in trucks. Because these interpretations were close to the intended Anthro interpretation in that they involve a turtle filling a role that is sometimes filled by a human (the 'passenger' role), *turtle truck* was added to the list of compounds that received Anthro interpretations to create 10 experimental items for the experiment.

5.2.1.2 Subjects

93 Rice University undergraduates enrolled in introductory linguistics courses participated in the experiment for extra credit. The results for 9 subjects were removed for reasons discussed in section 5.2.1.5 below. Of the 84 remaining subjects, 54 were female, 29 male, and 1 reported their gender as "none". All but 80 were native English speakers, meaning that they answered "yes" to a question of whether they learned English before age 8.

5.2.1.3 Materials

10 experimental compounds of the form Animal-Noun were selected based on the results from the norming task as described above. To create two lists of 25 items each, fillers were randomly selected from the norming task fillers (6 Animal-Animal, 6 Noun-Animal, and 28 Noun-Noun). Each of these were randomly split to provide the fillers for two lists. The experimental items were put into the two lists to make them as balanced as possible in terms of total Anthro interpretations and types of animals (categories such as fish, mammal, bird or predator/prey, etc.). Each list was pseudorandomized such that no two experimental

items occurred consecutively and so that the first experimental item appeared within the first 5 items of each list.

Reading passages were slightly altered versions of the passages used for *fish pencil* and *goat barbecue* in Experiment 2. A few minor word choice changes were made and it was ensured that both Animal and Human condition versions of each were 189-191 words long.

5 words were selected from each version of each passage to be used in a separate Definition task to which subjects were assigned. Each Definition task always included words that differed between the two versions of a given passage. Other words that were particularly relevant to the passage's meaning were selected for inclusion in the definition task. The lists of words were kept in the order in which they appeared in their corresponding passages. All materials for Experiment 4 can be found in Appendix E.

5.2.1.4 Design and procedure

Subjects were emailed a link to the experiment which they were instructed to complete within one week. The experiment used a 2 (Species: Animal vs Human) × 2 (Task: Read vs Define) factorial design. The structure of the experiment was the following for all subjects: i) complete the assigned task for Story 1 in one of the Species conditions ii) provide interpretations for one of the lists of compounds iii) complete the assigned task for Story 2 in the opposite condition from the first task iv) provide interpretations of compounds in the remaining list. Those assigned to the Reading task then answered a comprehension question pertaining to the first story. The final page for all subjects was a list of demographic questions regarding age, gender, academic major, number of semesters of college completed, whether subjects learned English before age 8, and whether subjects spoke a language other than English. The List Order and Species Condition Order were

counterbalanced, creating 8 blocks to which subjects were randomly assigned upon starting the experiment.

All subjects were instructed to complete the experiment on a nonmobile device in a quiet environment. Readers were instructed to read passages at a comfortable pace. They were informed that there would be a comprehension question at the end of the experiment. Definers were instructed to provide clear and concise descriptions of the meaning of each word in their definition tasks. They were informed that the purpose was simply to demonstrate that they know what the word means. For the compound interpretation task, subjects were given the same basic instructions as participants in the norming task: they should provide the first interpretation that comes to mind and avoid describing scenarios to which the compound might apply. They were informed that they would be providing interpretations for two different lists of 25 novel compounds. Each compound was presented in all caps with a hyphen separating constituents. All subjects had a brief practice session of their assigned task and of the interpretation task before continuing onto the experiment.

5.2.1.5 Initial coding and exclusion of subjects

Results were analyzed by the author and were first assessed with the goal of excluding subjects who did not follow directions or who appeared not to attend closely to the tasks. Responses to the reading comprehension question were assessed generously and only subjects who provided responses that reflected either no memory or inaccurate memory of the passage were removed. The reading comprehension question pertained to the first story in which a character named Amanda is going to smoke a cigarette and her friend, Beatrix, is expressing concern about her not quitting smoking. The reading comprehension question

asks why Amanda was upset with Beatrix. Note that the characters were erroneously switched and it should have asked why Beatrix was upset with Amanda. Very few participants seemed to notice this discrepancy. Most responded with something to the effect of "because she wanted her to quit smoking". A few participants corrected the question and stated that it was in fact Beatrix who was upset with Amanda. If a participant's answer referenced smoking or corrected the question is was counted as correct. Responses that were judged incorrect either stated something such as "I don't know" or "I don't remember" or they referenced something from either the practice passage or the other experimental reading passage. This second criterion for exclusion was chosen because such a response provides no affirmative evidence that the subject read the passage referenced by the question and because in those other two passages, there was no apparent conflict between characters. 7 subjects were removed on the basis of their response to the reading comprehension question.

Subjects in the definition task were given strikes for any vague or incorrect response or any response that showed they were thinking of a different sense of the word than was intended in the corresponding passage. Subjects who got more than one strike were removed. One subject was removed on the basis of their responses in the definition task. This subject defined two words using senses not intended in the reading passage.

As for the experimental compounds, subjects were removed if they provided three or more responses that were i) unclear ii) more of a description of a scenario in which the two nouns might occur or iii) a statement about the two nouns. One subject was removed on the basis of their responses to the experimental compounds. This subject consistently provided statements about the nouns and descriptions of scenarios involving the two nouns

rather than an interpretation. For example, this subject provided ‘there are not sheep at the amusement park’ in response to *sheep amusement*. As a result of these filtering criteria a total of 9 subjects were removed, leaving 84 subjects (41 readers, 43 definers).

Each response was coded “Anthro” or “non-Anthro” for Interpretation Type. Interpretations in which the animal named in the compound (or a similar animal) assumed a role in the head noun schema that is most typically filled by a human were coded Anthro and all others were coded non-Anthro. Table 5.5 provides paraphrases and descriptions of responses that were coded Anthro as well as rates at which such interpretations occurred for each item Finally, responses to demographic questions were coded. All responses that included one or more major of Linguistics, Psychology, or Cognitive Science were coded “CogSci”. All others were coded “Other”. Subjects who reported speaking another language (no level of proficiency was specified in the question) were coded True for Other Language.

5.2.1.6 Results and discussion

In general, the predicted rates of Anthro interpretations did not emerge. For readers, this rate increased slightly from Human (17.1%) to Animal (21.5%) condition, which is a much smaller effect than seen previously in Experiment 2, for example, where anthropomorphic rates increased from 11.1% to 26.7% between these conditions. In addition to the smaller effect of Species, Task appeared to make no difference. The Anthro rates for definers mirrored that of readers, barely increasing from 18.1% in the Human condition to 20.1% in the Animal condition. Figure 5.1 visualizes this lack of interaction.

A logistic mixed effects model predicting likelihood of an Anthro interpretation was built in R using the lme4 package (Bates et al. 2015). The initial model included Item as a

COMPOUND	PARAPHRASES OF ANTHRO INTERPRETATION(S)	ANTHRO RATE (%)
crab outrage	outrage experienced by crabs; when crabs are mad	32.1
elephant meeting	a gathering of elephants; a meeting in which elephants participate	47.6
frog television	a television that a frog watches	19.0
hawk hat	a hat or covering for a hawk's head	14.3
lizard game	a game that lizards play	9.5
shark razor	a razor for shaving sharks; a razor sharks shave with; a blade for trimming sharks' hair	6.0
sheep amusement	joy experienced by sheep; toys or games that amuse sheep	25
squirrel bottle	a bottle that holds food for squirrels; a bottle that squirrels drink out of; a bottle used to feed baby mammals	38.1
turtle truck	a truck that a turtle drives	0
wolf pencil	a pencil used by a wolf	2.4

Table 5.5 Paraphrases of interpretations coded Anthro for each experimental item and rates at which they occurred in Experiment 4.

random intercept. Potential predictors included nuisance variables (Gender, Age, Semesters of college completed, academic Major, Other Language, Native Speaker) and the experimental conditions (Task, Species, Condition Order). All possible interactions among experimental conditions were included as potential predictors. Each predictor was independently added to the model and the resulting change in AIC was observed. Whichever predictor lowered AIC the most was included in the new stage of the model. Once the model reached a stage at which the inclusion of no predictor lowered AIC, this stage represented the final model. None of the experimental conditions improved the model at any stage, meaning that we cannot reject the null hypothesis that Species and Task had no effect on Anthro interpretation rate.

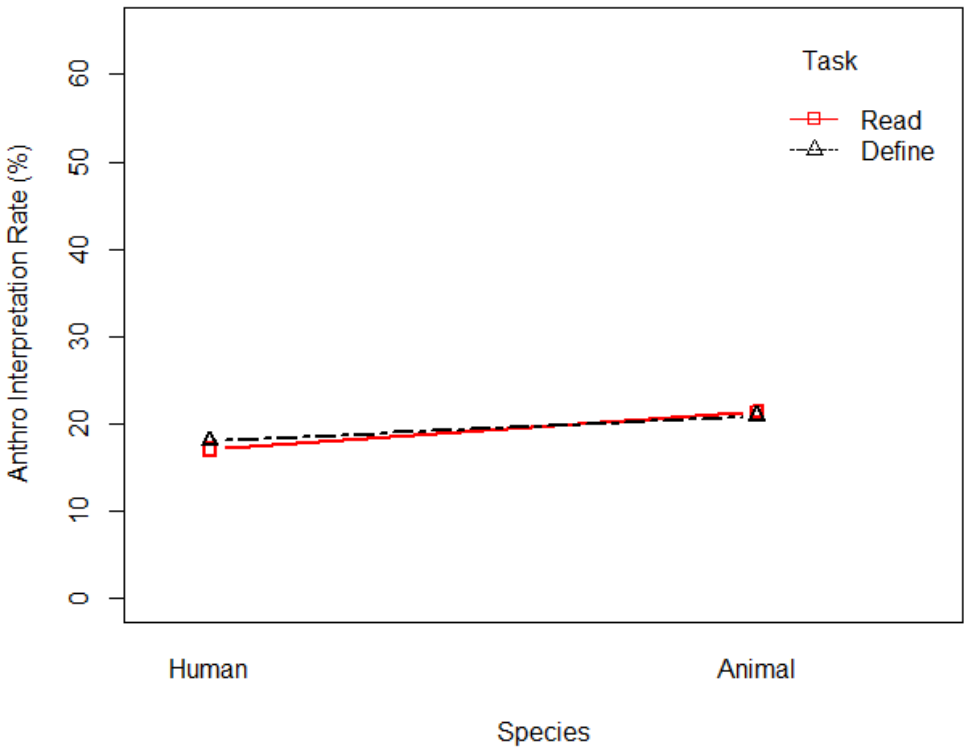

Figure 5.1 Anthro interpretation rate by Species and Task in Experiment 4.

The purpose of the Definition task was to rule out the possibility that the previously observed significance of Species was due simply to lexical or semantic priming. The lack of an effect of Species on readers makes the lack of a significant interaction between Task and Species uninformative. There are a few possible explanations for the disparate outcomes between the present and previous experiments. The first and most obvious of these is the fact that the experiments are not identical in design. In the previous experiments, subjects read a passage and then immediately after encountered a target compound to interpret. In the present experiment, subjects provided interpretations for lists of compounds. Attending to the task of interpreting a list of seemingly random compounds might be too cognitively taxing for any bias established while reading an anthropomorphic

PREDICTOR	COEFFICIENT	STANDARD ERROR	Z	*P*
Intercept	9.540	3.474	2.746	< 0.01
Age	-0.640	0.191	-3.349	< 0.001
Gender: Male	0.339	0.198	1.717	0.086
Gender: None	0.779	0.781	0.998	0.318
Semesters	0.327	0.107	3.067	< 0.01
Item (intercept)	1.854			

Table 5.6 Mixed effects logistic regression model predicting likelihood of Anthro interpretations in Experiment 4.

passage to be maintained. As can be seen in Table 5.5, a wide variety of rates of Anthro interpretations were found across items. This points to another possible consequence of planting experimental compounds within lists, which is that the ordinal placement within the list could affect the rate at which a compound receives an Anthro interpretation. In particular, those that occur earlier in the list could be more responsive to priming effects because there is less noise from interpreting other items in the list. This seems unlikely however, as a Pearson product-moment correlation revealed no relationship between Anthro rate and ordinal position within a list ($r(8) = 0.062$, $p = 0.864$).

The fact that some items elicited much fewer Anthro interpretations than others justifies further inspection of interpretation patterns of items based on these differences. Different patterns in the effects of experimental conditions could result from varying baseline Anthro interpretation rates. To examine this potential effect, the 10 experimental items were lumped into two even groups based on their overall rates. While it would be intuitive to categorize this baseline rate using the results from the norming task, there were much fewer interpretations for each item in the norming task (19) than in the main experiment (84). In the norming task, four of the ten items subsequently used in the experiment received more

than two Anthro interpretations. These four items also received the four highest rates of Anthro interpretations in the main experiment. However, there are then three items from the norming task which received exactly two Anthro interpretations. One of these (*frog television*) had the fifth highest Anthro rate in the main experiment at 19%. Because the Anthro interpretation rates in the main experiment mirror those from the norming task and because the precision is higher in the main experiment due to the larger number of observations, we can use the percentages from the main experiment to determine the cutoff for dichotomously categorizing items as having a high or low baseline Anthro interpretation rate.

Thus, the five items with the highest Anthro rates in the main experiment were placed in a group called "High Anthro" and the remaining five into a group called "Low Anthro". Basic interpretation patterns suggest that High Anthro and Low Anthro items are differentially affected by Task and Species. For High Anthro items, Anthro rate for readers increases from 28.6% in the Human condition to 38% in the Animal condition. For those same items, there appears to be no effect of Species on definers' rates of Anthro interpretations: 32.4% in the Human condition and 30.9% in the Animal condition. For Low Anthro items, the effect of Species was smaller and patterned in the opposite direction for both tasks. Going from the Human to the Animal condition, the Anthro rates for readers decreased from 6.7% to 4% while these rates increased for definers from 4.8% to 10%. Figures 5.2 and 5.3 visualize the different effects of Task and Species on High Anthro and Low Anthro items respectively. The greater effect of Task and Species patterning in the predicted direction for High Anthro items paired with the smaller effect and unpredicted pattern on Low Anthro items suggests that the norming procedures implemented failed to

generate experimental compounds with sufficiently competitive Anthro interpretations. In short, the effect of Species observed in Experiments 1-3 might only be relevant for compounds with Anthro interpretations that are reasonably likely in the first place.

The apparent need for a certain baseline Anthro interpretation rate to produce the intended priming effect speaks to the complexity of compound interpretation. There are likely a large number of factors that motivate the potential interpretations of any compound. The mere presence of a relatively abstract schema that is consistent with a particular interpretation does not necessarily make that interpretation more likely. The strength of other interpretations due to people's knowledge about each noun concept also matters. A maximally top-down conceptual path is not inherently preferred over other ways

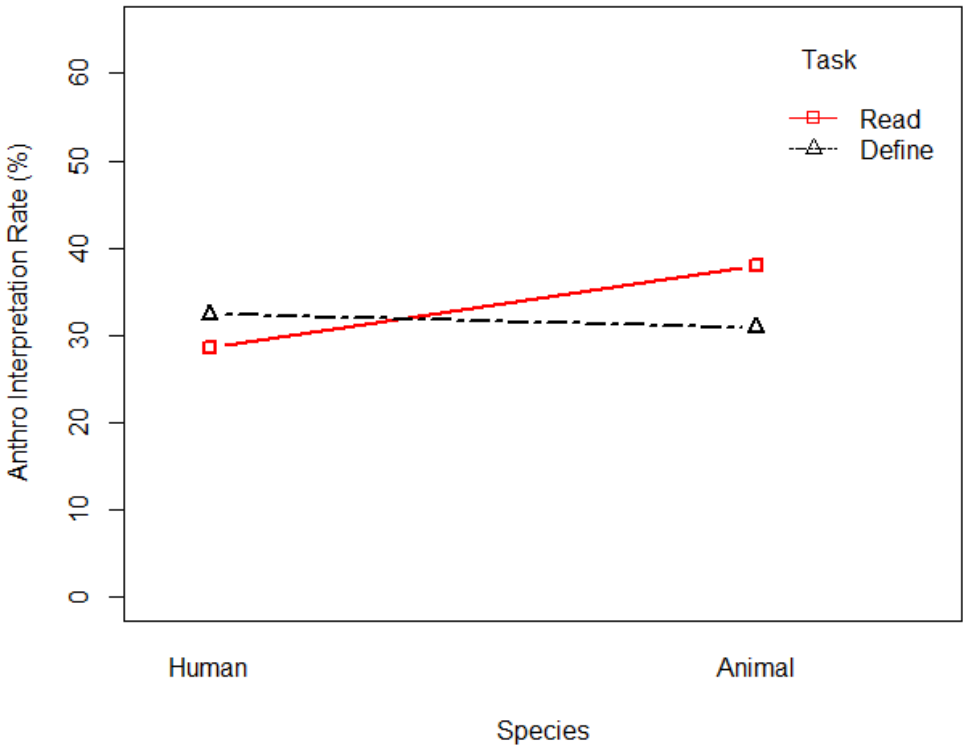

Figure 5.2 Anthro interpretation rate by Species and Task for High Anthro items in Experiment 4.

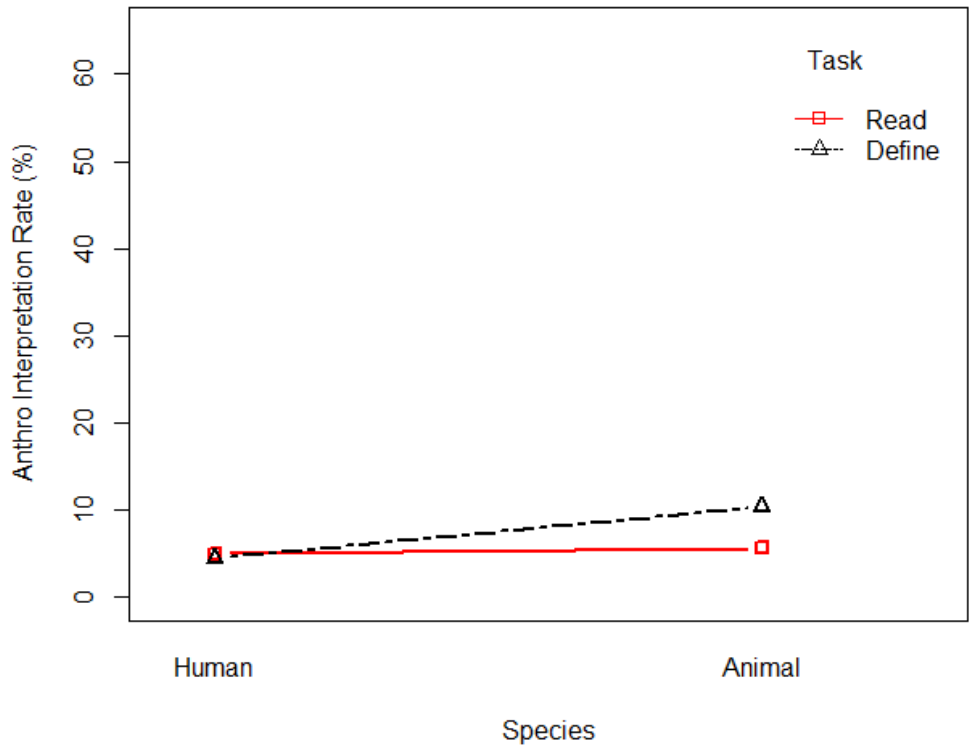

Figure 5.3 Anthro interpretation rate by Species and Task for Low Anthro items in Experiment 4.

of integrating knowledge of each noun to interpret a novel compound. But perhaps given a certain level of consistency with interpretations that are motivated by other more specific schemas, the recent formation of a relatively abstract schema can successfully bias people toward a certain interpretation.

In reviewing the interpretations provided in Experiment 4, a potential confound emerged which relates to Lynott and Connell's (2010b) categorization of NN compound meanings as destructive and nondestructive. These ideas are somewhat analogous to the categories of property and relation-based interpretations. Nondestructive interpretations are interpretations in which neither noun is "reduced" to some property of itself. An example of such an interpretation would be *elephant table* as 'a table that an elephant is on'. Meanwhile, destructive interpretations involve reducing one or more of the nouns to

some element of the noun. A destructive interpretation of *elephant table* would be ‘a large table’, where *elephant* is reduced to the property of bigness. Lynott & Connell suggest that there could be different processes for generating these different types of interpretations and that they may not happen in parallel. If that is the case, then the influence of Species on Anthro in Experiments 1-3 and for the High Anthro items in the present experiment, could simply result from biasing toward an interpretation in which the animal concept is preserved, i.e. the interpretation assumes the presence of an entity that corresponds to the animal named in the compound. For clarity and simplicity we can use the variable ENTITY to refer to this dichotomy.

For 3 of the 4 compounds tested in Experiments 1-3, there were no competitive Entity interpretations aside from the target Anthro interpretations. Aside from their Anthro interpretations, *crab shirt* was typically interpreted as ‘a shirt with a crab picture on it’, *fish pencil* as ‘a pencil with fish images on it’ or ‘a pencil in the shape of a fish’, and *goat barbecue* as ‘barbecued goat meat’. In the last, Goat is reduced to its meat. Interestingly, the one compound from Experiment 2 which originally did not show the predicted effect of Species, *bear gun*, is the one item for which a non-Anthro, Entity interpretation was often given: *bear gun* as ‘a gun that one uses to hunt bears’. Though subjects were subsequently biased toward the target interpretation for this item in Experiment 3, this result gives us all the more reason to take the potential confound of Entity interpretations seriously.

Anthro interpretations are a subset of Entity interpretations, so if the results in Experiments 1-3 are simply due to priming for Entity interpretations, we would expect Task and Species to have similar effects on the rate of non-Anthro Entity interpretations as

they have on Anthro interpretations. In other words, we have a new null hypothesis that Anthro interpretations are a nonspecial case of Entity interpretations. To explore this idea, all responses were coded True or False for the variable Entity. First, all Anthro responses were coded "True" for the variable Entity. Non-Anthro responses were then examined to see whether they involved an entity corresponding to the animal named in the compound (or a similar animal).

For High Anthro items, where we saw better evidence for the predicted effect of Task and Species on Anthro rate, the non-Anthro Entity rates did not mirror the Anthro rates. Whereas the Anthro rate increased roughly 10% for readers and decreased nearly 3% for definers going from Human to Animal condition, the non-Anthro Entity rate decreased from 15.2% to 11% for readers and marginally increased from 18.1% to 20% for definers. One can see the differential effect of Task and Species on Anthro and non-Anthro Entity rates on High Anthro items by comparing Figures 5.2 and 5.4.

In Experiment 4 Species did not have the same effect on Anthro rates for readers as it did in Experiments 1-3. This inconsistency between experiments could be due to a number of factors such as the design change of interpreting a single compound after a passage vs interpreting a list of 25 compounds after a passage. It could also be due to a failure in the normalization procedures to produce Animal-Noun compounds that reliably result in competitive Anthro interpretations. For those items that had a higher baseline rate of Anthro interpretations, Anthro rates trended toward the predicted interaction between Task and Species, albeit to a smaller degree than was observed in Experiments 1-3. Another potential confound was observed in the possibility that reading about animals simply biases subjects toward Entity interpretations. In the absence of a competitive, non-Anthro Entity

interpretation we would expect Anthro interpretations to increase under such circumstances. Though it does not provide firm conclusions, it is a positive sign for the dynamic schema view that non-Anthro Entity rates did not mirror the Anthro rates for High Anthro items.

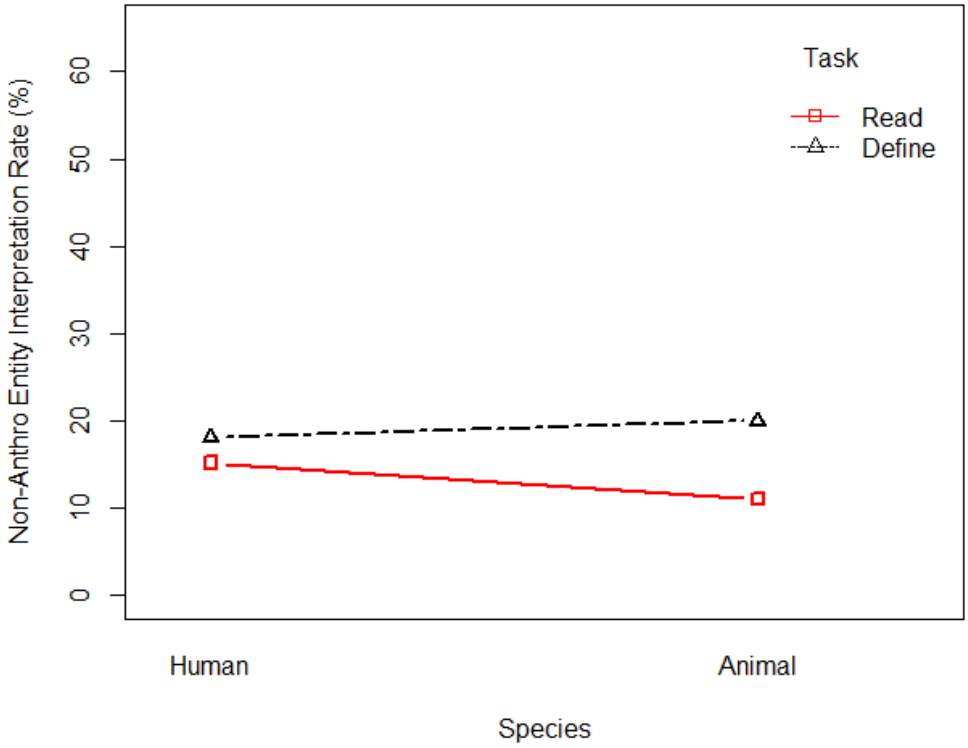

Figure 5.4 Non-Anthro Entity interpretation rate by Species and Task for High Anthro items in Experiment 4.

5.2.2 Experiment 5

Like Experiment 4, Experiment 5 attempted to extend the results from Experiments 1-3 to more compounds while controlling for lexical and semantic priming. Accordingly, Experiment 5 included new experimental compounds and maintained the inclusion of the

Definition task in which subjects define sets of words found in passages encountered by subjects in the Reading task.

Additional design changes were implemented in the present experiment in light of Experiment 4's failure to replicate the effect of Species for readers. These changes are motivated by two potential explanations for the discrepancy between Experiment 4 and Experiments 1-3. First, the design differences between Experiment 4 and the prior experiments, which were chosen in order to increase the number of Animal-Noun compounds interpreted, could have weakened the potential priming effect. In Experiments 1-3, subjects read a passage and then interpreted a single compound immediately afterward. In Experiment 4 subjects read a passage (or defined corresponding words) and then interpreted a list of noun-noun compounds, some of which were target Animal-Noun compounds. Embedding a variety of Animal-Noun compounds among a larger number of filler compounds could weaken any priming effect because the task of interpreting a list of ambiguous compounds could be too distracting or involve too much conceptual variety. Accordingly, in place of having subjects complete two priming tasks, each followed by a list of 25 compounds to be interpreted, in Experiment 5 subjects completed 10 priming tasks (either Reading or Defining) each followed by the interpretation of 2 compounds.

The second explanation for Experiment 4's lack of effect of Species on readers is that Animal-Noun compounds were not selected that had a sufficient baseline of Anthro interpretations. In Experiment 4, compounds which received more Anthro interpretations in general had Anthro interpretation rates that were more consistent with the predicted interaction between Task and Species. The norming task in the present experiment was

therefore designed to better select for Animal-Noun compounds that are more likely to prompt an Anthro interpretation in isolation.

An additional change in the construction of materials between the present experiment and Experiment 4 is motivated by the consideration of the potential confound between Entity and Anthro interpretations. Without a competitive interpretation which is both non-Anthro and assumes the holistic presence of the animal named in the compound, any priming effects could potentially result from subjects in the Animal condition having thought about an animal in general. The norming procedures for the present experiment were accordingly designed to target Animal-Noun compounds for which both Anthro and non-Anthro Entity interpretations are provided when encountered in isolation.

5.2.2.1 Norming

For Experiment 5 a norming task was designed to better select Animal-Noun compounds which have a reasonable likelihood of prompting both an Anthro and a non-Anthro Entity interpretation when encountered in isolation. Rather than randomly pair animals with a semantically varied set of nouns, as was done in Experiment 4, first a list of Animal-Noun compounds was created which intuitively seemed likely to produce Anthro and non-Anthro Entity interpretations. This list was winnowed following the same criteria used in Experiment 4: each constituent occurred more than 1000 times in COCA, each constituent having a Nouniness score above 95%, and each compound occurring 0 times in COCA. 32 Animal-Noun compounds remained after this process.

To create lists that balance the four different compound types similarly to how they were balanced in Experiment 4's norming task, three lists of 50 compounds were created, two of which included 11 Animal-Noun, 29 Noun-Noun, 5 Animal-Animal, and 5 Noun-

Animal compounds, and one of which was the same except it had 10 Animal-Noun compounds (rather than 11) and 30 Noun-Noun compounds (rather than 29). To create 88 Noun-Noun compounds, the non-Animal nouns were randomly paired together into 128 compounds, each noun appearing 4 times in each constituent position. Redundant compounds (those that occurred more than once and those in which the constituents were the same) were removed. 88 compounds were then randomly selected for use in the norming task. 15 Noun-Animal compounds were selected by taking the list of 32 Animal-Noun compounds, switching the constituent positions, randomly ordering each constituent list, and then randomly selecting 15 nonredundant compounds. To create 15 Animal-Animal compounds, the 17 Animal nouns that were not found in any of the Noun-Animal compounds were randomly paired, creating 17 Animal-Animal compounds in which each noun appears in each constituent position only once. 15 nonredundant compounds were randomly selected from this list, completing the construction of compounds to be used in the norming task. Each compound was searched for in COCA and if it occurred, it was replaced by a comparably randomly generated compound that did not occur. Each compound type was randomly sampled to create the three lists described above. Each of these lists was pseudorandomized such that no two Animal-Noun compounds ever occurred sequentially.

49 subjects (21 male, 27 female, 1 transgender man) recruited through Amazon Mechanical Turk completed the norming task for $2. Through this platform, they were provided a link to the experiment. Results for six subjects were removed from analysis because of failure to follow instructions. Though the lists were shorter than in the norming task for Experiment 4, the instructions and practice session remained the same. Each of the

three lists was split in half and the order of presentation of the two halves was counterbalanced. Between the two halves of each list, subjects were encouraged to take a short break if needed. Each subject provided interpretations for one of the lists.

Due to a programming error, each list was not seen the same number of times. Excluding subjects who were removed for not following directions, the three lists were interpreted 10 times, 15 times, and 18 times respectively. Despite this imbalance, strong candidates emerged from the process to use as target compounds in the main experiment. Each of the 32 compounds were coded True or False for the variable Anthro and for the variable non-Anthro Entity. 7 compounds received Anthro and non-Anthro Entity interpretations more than 20% of the time. For one of these, the distinctions used for coding interpretations as Anthro or non-Anthro Entity seemed less clear. The remaining 6 were selected for use in the main experiment as target compounds and can be found along with their respective rates of Anthro and non-Anthro Entity interpretations in Table 5.7.

COMPOUND	ANTHRO INTERPRETATION RATE (%)	NON-ANTHRO ENTITY INTERPRETATION RATE (%)
horse boss	30	40
pig boot	50	22.2
cat theology	27.8	38.9
rhino road	44.4	33.3
lion reconnaissance	38.9	38.9
bird routine	44.4	22.2

Table 5.7 Animal-Noun compounds selected for Experiment 5 and norming task interpretation rates.

5.2.2.2 Subjects

93 Rice University undergraduates enrolled in introductory linguistics courses participated in the experiment for extra credit. The results for 14 subjects were removed because of lack of clarity, failure to follow directions, etc., which is described more fully in Section 5.2.2.5 below. Of the 79 remaining subjects, 43 were female, 35 male, and 1 identified as "nonbinary". All but 7 were native English speakers, which was defined by answering "yes" to a question of whether they learned English before age 8.

5.2.2.3 Materials

6 experimental compounds of the form Animal-Noun were selected based on the results from the norming task as described above. 14 nonredundant filler compounds were then created to accompany the target compounds. These were constructed by randomly pairing the non-Animal nouns from the norming task. 10 passages were written, each of which was intended to precede a particular pair of compounds to be interpreted. Each was 190 to 200 words long. 6 of these were designed as priming passages to respective experimental compounds. For each of the experimental passages, there were two versions, an Animal condition version and a Human condition version. The two versions differed in only one word which was found in the first sentence of the passage. In the Animal condition this word is the animal named in the target Animal-Noun compound and in the Human condition the word is some noun which refers to humans, such as "kids", "men", or "friends". The four remaining passages were filler passages. These did not have different conditions. All passages introduced two characters in the first sentence and portray a scene between them in which their location, actions, and dialogue are described. For each

passage, the target experimental compound was randomly paired with a filler compound to create a list of two compounds to be interpreted following the passage (or respective definition task). The remaining eight filler compounds were randomly grouped into pairs of two and those pairs were randomly paired with one of the four filler passages. For the six compound pairs that included an experimental compound, half were ordered with the experimental compound occurring before the filler compound. The remaining compound pairs featuring an experimental compound were put in the opposite order.

Finally, for each version of each passage, a list of words to be defined by those in the corresponding Definition task was created. In Experiment 4 it was noted that the time spent on each Reading passage was slightly shorter than the time spent on the corresponding Definition tasks. To make the times more comparable and because subjects would be doing 10 such tasks in Experiment 5 (rather than two in Experiment 4), three words to be defined were selected from each passage rather than five. The words from the passage were chosen based on their relevance to the overall passage. Only content words were selected and those that played the biggest role in the plot or scene of the passage were sought. For example, words referring to objects the characters do something with or the location of the characters' interaction were often chosen. For the Definition lists corresponding to the experimental passages, the words by which the Animal and Human conditions differ were respectively chosen as the first of the list. The words for the Definition lists were placed in the order in which they occurred in the passage. All materials for Experiment 5 are found in Appendix F.

5.2.2.4 Design and procedure

Subjects were emailed a link to the experiment which they were instructed to complete within one week. The experiment used a 2 (Species: Animal vs Human) × 2 (Task: Read vs Define) factorial design. All subjects completed ten pairs of priming and interpretations tasks. Readers read a passage and then interpreted two compounds a total of ten times. Compounds appeared on the screen one at a time in all caps with the constituents separated by a hyphen. The structure of the experiment for definers was identical except that each passage was replaced by the corresponding list of three words to be defined (all displayed on the screen simultaneously). Additionally, attention checks were included for readers by having them answer comprehension questions pertaining to the second and fourth filler passages immediately after interpreting those passages' respective compounds. The final page for all subjects was the same list of demographic questions given to subjects in Experiment 4. The Item Order and Species Condition Order were counterbalanced, creating 8 blocks to which subjects were randomly assigned upon starting the experiment. Two item orders were created by pseudorandomizing the order of presentation of the 10 priming and interpretation task pairs such that no more than two experimental pairings occurred in a row and filler pairings never occurred consecutively. As an additional constraint, the fillers occurred in the same order in both lists, though not in the exact same position. For each Item Order, Species Condition Order was counter-balanced. In each Item Order Species alternated between Human and Animal conditions, the difference between the Species condition orders being which condition was encountered first. This method of balancing meant that there were at least two prime-compound pairings intervening between any two experimental pairings of the same Species condition.

The instructions were nearly identical to those in Experiment 4. Some changes to the description of the general structure of the experiment were of course necessary. Additionally, minor changes were made to shorten the instructions section. Subjects were given a practice item after the instructions just as in Experiment 4.

5.2.2.5 Initial coding and exclusion of subjects

Results were analyzed by the author and were first assessed with the goal of excluding subjects who did not follow directions or who appeared not to attend closely to the tasks. First, two subjects were removed because they had to start the experiment over after starting it because they had not understood the instructions. Responses to the reading comprehension questions were assessed generously and only subjects who provided a response to a comprehension question reflecting either no memory or inaccurate memory of the passage were removed. The first comprehension question pertained to the second filler passage and immediately followed the passage's respective compound pairing. This passage depicted a scene between two characters who are at work sorting packages for the postal service. The question asks where the characters work. Examples of responses that were judged inaccurate are "at a bowling alley", "pizza place", and "I forgot". The second comprehension question immediately followed the compound pairing that followed the fourth and final filler passage. It depicted a scene between two characters, Felix and Sasha, who work at a restaurant. Felix has a short temper and gets angry at Sasha for failing to substitute a salad for fries on a customer's order. The question asks why Felix got angry at Sasha. Responses judged incorrect were "Sasha cheated", "For smoking" (a reference to one of the experimental passages), and "I do not remember". 7 subjects were removed because of an incorrect answer to a reading comprehension question.

As in Experiment 4, subjects in the Definition task were given strikes for any vague or incorrect response or any response that showed they were thinking of a different sense of the word than was intended in the corresponding passage. Because definers in the present experiment defined three times as many items as those in Experiment 4, subjects were removed if they received more than three strikes (rather than one, which was the criterion for exclusion in Experiment 4). This applied to one subject who defined four words with a different sense than was intended in the words' corresponding passages.

Subjects were also assessed strikes for their responses to experimental compounds in the same manner as in Experiment 4. Those who were given two or more such strikes were removed. Examples of responses assessed strikes include, for *bird routine*: "a rooster wakes you up in the morning", for *pig boot* "right at home in the mess, his pig chewed contently on his boots", for *lion reconnaissance* "meeting place of lions", for *rhino road* "rhinos do not use roads", and for *horse boss* "a horse is not in the position to be someone's boss". Four subjects were removed on the basis of their responses to experimental compounds. In total, 14 subjects were removed, leaving 79 subjects (34 readers, 45 definers) for analysis.

Before responses were coded, it was noted that several subjects either misread *lion reconnaissance* as *lion renaissance* (as evidenced by the interpretation provided) or thought that *reconnaissance* referred to some sort of meeting rather than a stealthy fact-finding mission. These individual items were removed from analysis resulting in *lion reconnaissance* having seven fewer observations than the other five items. This left 467 responses to experimental items for coding and analysis.

All responses were coded "Anthro" or "non-Anthro" for the variable Interpretation Type. Interpretations in which the animal named in the compound (or a similar animal) assumed a role in the head noun schema that is most typically filled by a human were coded Anthro and all others were coded non-Anthro. Table 5.8 provides paraphrases and descriptions of the types of responses that were coded Anthro as well as rates at which such interpretations occurred for each item.

COMPOUND	PARAPHRASES OF ANTHRO INTERPRETATION(S)	ANTHRO RATE (%)
bird routine	routine a bird does; routine of a bird; daily habits of a bird	50.6
cat theology	anything suggesting cats' religious, moral, or philosophical beliefs or cats' investigation into these topics	30.3
horse boss	a boss that is a horse; a horse that leads other horses	12.7
lion reconnaissance	reconnaissance done by lions; a lion's stalking of prey; surveying an area done by a lion	31.9
pig boot	boot worn by a pig; a pig's boot	45.6
rhino road	road which rhinos travel on; a road made by rhinos	45.6

Table 5.8 Interpretations coded Anthro for each experimental item and rates at which they occurred in Experiment 5.

Responses to demographic questions were coded following the same criteria as in Experiment 4.

5.2.2.6 Results and discussion

The predicted pattern of Anthro interpretation rates emerged in the present experiment. For readers, the rate of Anthro interpretations increased from 25% to 50.5% going from Human to Animal conditions. For definers, this same change in Species condition resulted in a

decrease of Anthro interpretations from 39.6% to 30.6%. This interaction is visualized in Figure 5.5.

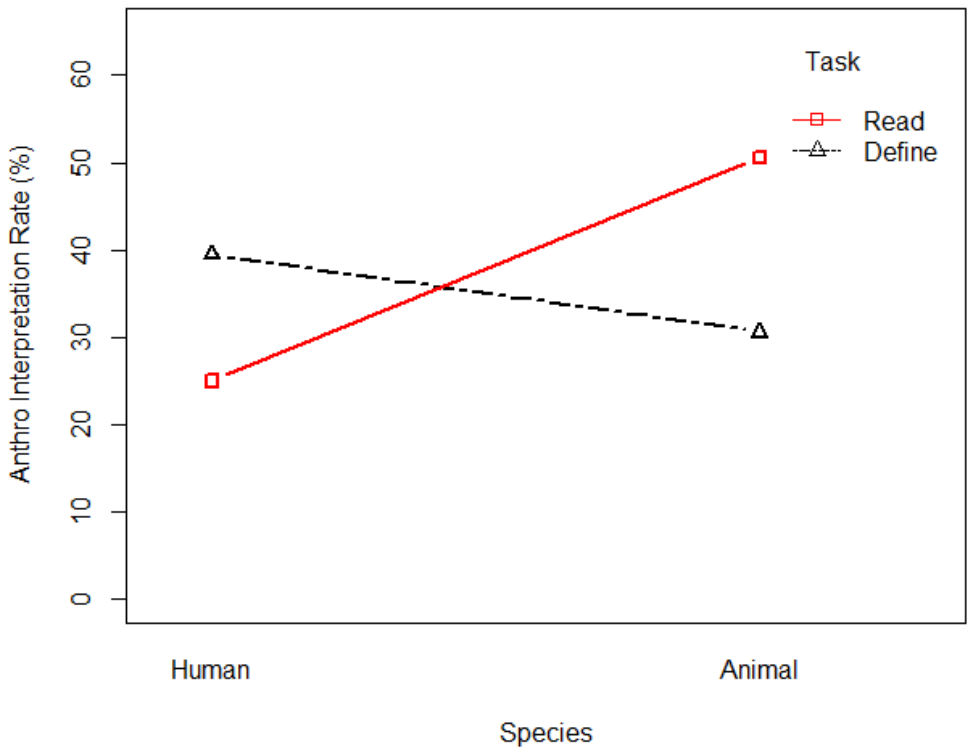

Figure 5.5 Anthro interpretation rate by Species and Task in Experiment 5.

To test whether this apparent interaction was significant, a mixed effects model was built following the same step-wise procedure as in Experiment 4. The initial model included Item as a random intercept. Predictors included nuisance variables (Gender, Age, Semesters of college completed, academic Major, Other Language, Native Speaker) and the experimental conditions (Task, Species, Item Order, Condition Order). All two-way interactions between experimental conditions were included as potential predictors. Each predictor was independently added to the model and the resulting change in AIC was observed. Whichever predictor lowered AIC the most was included in the new stage of the

model. Once the model reached a stage at which the inclusion of no predictor lowered AIC, this stage represented the final model. The resulting model showed the observed interaction between Task and Species to be significant (β = -1.6237, SE = .4197, $p < .001$) as well as the fixed effects of Task (β = .84, SE = .3046, $p < .01$) and Species (β = 1.2258, SE = .3203, $p < .001$). These coefficients taken together indicate that i) definers were significantly more likely to provide Anthro interpretations of Human condition items than were readers ii) readers were more likely to provide Anthro interpretations in the Animal condition than they were in the Human condition iii) these effects play out differentially, such that definers were only slightly more likely to give Anthro interpretations to Animal condition items than readers were to Human condition items. The final model also included Native Speaker status (β = 1.3975, SE = .4681, $p < .01$) and Other Language (β = .3887, SE = .2558, p = .1286). The full model is presented in Table 5.9.

PREDICTOR	COEFFICIENT	STANDARD ERROR	*Z*	*P*
Intercept	-2.8820	0.6267	-4.599	< .001
Task: Define	.8400	.3046	2.758	< .01
Species: Animal	1.2258	.3203	3.826	< .001
Native Speaker: Yes	1.3975	.4681	2.986	< .01
Other Language: True	.3887	.2558	1.520	.1286
Task: Define × Species: Animal	-1.6237	.4197	-3.869	< .001
Item (intercept)	.3852			

Table 5.9 Mixed effects logistic regression model predicting likelihood of Anthro interpretation in Experiment 5.

The effect of Species was further tested for readers and definers individually. The same method of model building was followed as before. The same nuisance and experimental variables, and interactions among experimental variables were considered. For definers, at no stage did Species improve the model, indicating that the decrease in Anthro interpretation rates going from Human to Animal conditions was not significant. In the final model for readers, the main effects of Species (β = 0.4836, SE = 0.4039, $p > 0.05$) and Item Order (β = -0.6177, SE = 0.4985, $p > 0.05$) were not significant but an interaction between the two was (β = 1.7694, SE = 0.6700, $p < 0.01$).

In addition to the significant interaction with Item Order, there are several reasons that the lack of a main effect of Species for readers does not undermine the experiment's confirmation of predictions. First, the descriptive statistical pattern of Anthro rates in response to Task and Species were as predicted, indicating that the significant interaction between Task and Species is not due to significant effects in the wrong direction. Second, the subject exclusion process resulted in much fewer readers. Originally there were 46 readers and 47 definers in the experiment, but the data from 12 readers and 2 definers were removed from analysis, resulting in only 34 readers whose data was analyzed. This generally weakens tests of significance restricted to readers. Third, the subjects who were removed were disproportionately drawn from those who encountered items in Order 2. As a result, results for only 14 readers who encountered items in Order 2 were analyzed. This compares to the 20 readers who encountered items in Order 1 and whose data was analyzed. This interference with the intended counterbalance matters because it appears that the intended effect of Species, though present for both Item Orders, was stronger for readers in Item Order 2 than for Item Order 1. Going from Human to Animal condition, the Anthro

interpretation rate for readers in Item Order 1 increased from 29.31% to 39.66% while for readers in Item Order 2 this rate more than tripled from 19.05% to 65.85%. There is a plausible explanation for this discrepancy. In Item Order 1, the first item encountered is a filler, but for Item Order 2 the first item encountered is an experimental item. Because the filler items are consistent with the real world and are not followed by any compounds referencing animals, this could result in readers in Item Order 1 interpreting target compounds at rates closer to the baseline. Indeed, the overall Anthro rate for readers in Item Order 1 (34.48%) is almost identical to the overall rate of definers (35.07%) in the experiment.

As a sanity check, we can observe the effect of Species for readers and definers by creating a model with Item as a random intercept and Species as the only other predictor. Within definers, doing so shows Species not to be significant (β = -0.4690, SE = 0.2765, $p > 0.05$) while within readers Species is a significant predictor (β = 1.1492, SE = 0.3118, $p < 0.001$). This is what we would expect given that readers doubled their rate of Anthro interpretations going from Human to Animal conditions.

Experiment 5 succeeded in replicating the results of Experiments 1-3 while providing stringent controls for lexical and semantic priming. Because definers' tasks differed by the same words as were varied in the reading passages between Human and Animal conditions, we can rule out the possibility that the predicted pattern in Anthro interpretations for readers was simply due to subjects having encountered the word for the animal named in the compound or having thought about the animal prior to interpreting the compound. This suggests that the psychological accessibility of the lexical item or the corresponding

conceptual representation of a noun referring to an animal does not generally prime someone to interpret ambiguous language anthropomorphically.

Comparison of Anthro rates among the four possible combinations of Task and Species conditions suggest that in both Human and Animal conditions, readers are being actively primed through the use of schemas and conceptual blending. The Anthro interpretation rate was lowest for readers in the Human condition while it was highest for readers in the Animal condition. The rates for definers in each Species condition were between those two extremes. Readers in the Human condition would understand a passage by continually invoking schemas of normal human activities and mapping human characters onto the roles typically filled by humans. Readers in the Animal condition, however, understand a passage by continually mapping animals onto the roles typically filled by humans. The amount and necessity of such mappings, whether anthropomorphic or "normal", is far greater for readers than it is for definers. Though many of the definitions provided by definers assume a role filled by a human, definers only define three words per Definition task and each definition is provided on its own. That is to say, definers are not prompted to integrate the concepts represented by the three words in a Definition task in any particular way.

The Anthro rates for the four combinations of Task and Species condition can thus be explained in terms of degrees of biasing toward particular conceptual blends. Definers in the Human condition can be thought of as the most "neutral" with respect to such priming because they define only a few words, none of which refer to an animal. This means their priming task entails a relatively small amount of mapping humans onto roles typically filled by humans and no particular bias with respect to the animal named in the target compound.

The fact that the Anthro interpretation rate for this group (39.6%) is almost identical to the Anthro interpretation rate for those same six compounds in the norming task (39.3%) further validates this idea.

Readers in the Human condition are more actively biased toward real-world plausible interpretations because their priming task involves perpetual mapping of human characters onto roles typically filled by humans in schemas of everyday human activities. Thus when they encounter the target compound, they are more likely to do so by creating a conceptual blend in which a human is mapped onto the typically human role in the head noun's schema. The even lower rate of Anthro interpretations for this condition pairing (25%) reflects the decreased probability of an Anthro mapping which results from the construction of blends in which human characters are mapped onto typical human roles. Finally, readers in the Animal condition are actively biased toward Anthro interpretations through the process of constructing conceptual blends in which the animal named in the target compound fills the role typically filled by humans in everyday human affairs. The Anthro interpretation rate for this condition pairing (50.5%), which is the highest of all four pairings, rounds out the pattern expected if conceptual blending plays a central role in the comprehension of NN compounds: those who have been the most directly prompted to create blends that are consistent or inconsistent with the target Anthro interpretation are respectively the most and least likely to provide such an interpretation.

In the discussion of Experiment 4, the potential confound of Entity interpretations was raised. Accordingly, compounds were selected for Experiment 5 which seemed to prompt for a nontrivial amount of both Anthro and non-Anthro Entity interpretations. By having compounds that produce both kinds of interpretation, we can additionally confirm whether

the patterns in Anthro interpretation are in any way explained as simply priming for Entity interpretations. To that end, all responses to experimental items were dichotomously coded True/False for the variable Entity. All responses coded Anthro were automatically coded True for Entity. Additionally, all other responses were manually assessed as to whether or not the interpretation involved the holistic occurrence of an entity corresponding to the animal named in the compound. Examples of non-Anthro Entity interpretations are the following: for *bird routine* 'the things one regularly does to take care of a pet bird'; for *cat theology* 'the study of religions in which people worship cats'; for *horse boss* 'someone in charge of horses'; for *lion reconnaissance* 'reconnaissance in search of lions'; for *pig boot* 'a type of boot you wear to work with pigs'; *rhino road* 'a road with rhinos on it'. These non-Anthro Entity interpretations did not pattern similarly to the Anthro interpretations. For readers, there was a higher rate of non-Anthro Entity interpretations in the Human condition (26%) than in the Animal condition (17.2%). For definers this pattern was switched, with a higher rate in the Animal condition (42.5%) than in the Human condition (38.8%). This interaction is visualized in Figure 5.6.

The fact that non-Anthro Entity interpretations pattern in the opposite direction from Anthro interpretations allows us to rule out general Entity priming for the effect of Species on readers. If the difference between conditions were due to subjects in the Animal condition simply being more likely to provide an interpretation that involves an actual animal, we would expect other Entity interpretations to pattern similarly in relation to Task and Species. Clearly, they do not.

In selecting compounds that reliably prompt for both Anthro and non-Anthro Entity interpretations, it was hoped that the patterns observed for High Anthro items in

Experiment 4 could be reproduced. Comparison of Figures 5.5 and 5.2 as well as Figures 5.6 and 5.4 shows the present experiment to be a success in this regard. In a similar parallel to Experiment 4, the only item whose Anthro interpretations failed to pattern in a manner consistent with the predicted interaction was the one item which received a remarkably lower rate of Anthro interpretations throughout the whole experiment (*horse boss*). Anthro rates by condition are found for each item in Table 5.10.

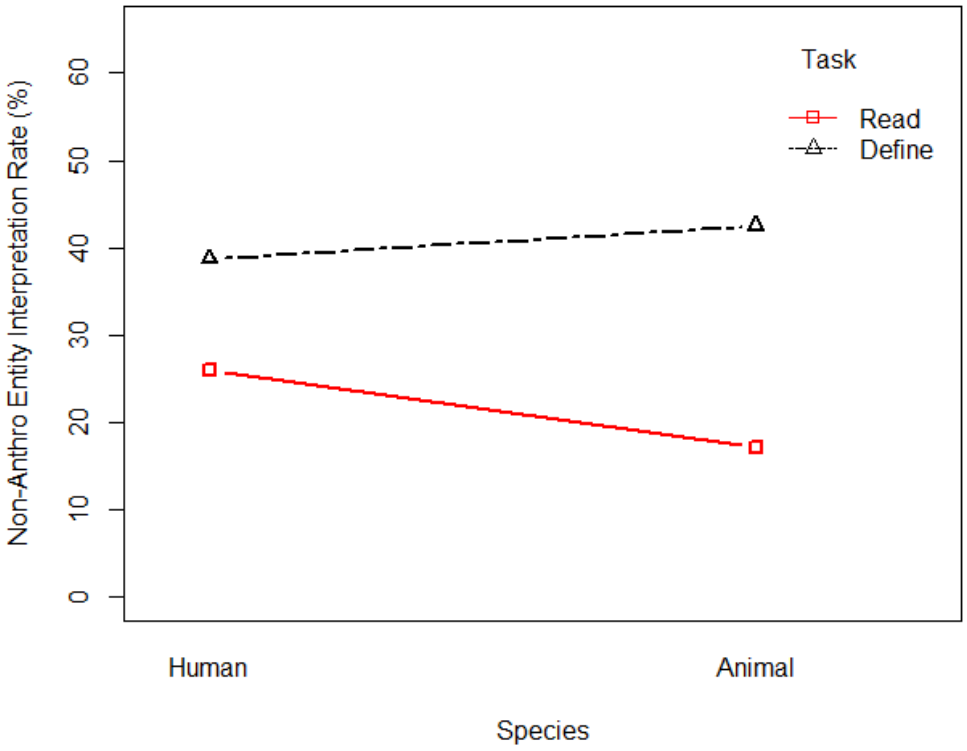

Figure 5.6 Rate of non-Anthro Entity interpretations by Task and Species in Experiment 5.

All items but *horse boss* were given Anthro interpretations more than 30% of the time throughout the experiment. With the exception of *horse boss*, all items additionally show the expected increase from Human to Animal condition for readers.

		READ	DEFINE	ALL CONDITIONS
bird routine	HUMAN	33.3	64.0	50.6
	ANIMAL	56.3	45.0	
cat theology	HUMAN	27.8	20.0	30.4
	ANIMAL	62.5	20.0	
horse boss	HUMAN	18.8	10.0	12.7
	ANIMAL	16.7	8.0	
lion reconnaissance	HUMAN	25.0	16.7	31.9
	ANIMAL	61.5	36.8	
pig boot	HUMAN	18.8	75.0	45.6
	ANIMAL	61.1	28.0	
rhino road	HUMAN	25.0	55.0	45.6
	ANIMAL	50.0	48.0	

Table 5.10 Anthro interpretation rates by Task and Species by Item in Experiment 5.

These trends further validate the possibility that the lack of an effect from Task or Species in Experiment 4 was due to many of the items' target interpretations being insufficiently probable in the first place. The consistency of this pattern between Experiments 4 and 5 reminds us of the obvious fact that the conditions controlled in these experiment are not the only factors motivating interpretations of novel compounds. Cultural depictions of particular animals, probabilistic knowledge of how each constituent is used in other compounds, and a seemingly endless variety of world knowledge could all play a role. Regardless of the variety or weighted importance of other factors which constrain the interpretation of novel compounds, the present experiment clearly demonstrates that the integration of schematic conceptual knowledge plays some role.

5.2.3 Summary

Two experiments attempted to replicate the results of Experiments 1-3 while extending the observed effect of passage conditions to more items and additionally controlling for lexical and semantic priming. The inclusion of a Definition task helps rule out non-schema-based explanations for the results in Experiments 1-3. In the first three experiments, the effect of Species on Anthropomorphic interpretation rates could have been due to the fact that those in the Animal condition read about an animal while those in the Human condition did not. That is to say that simply processing the word for an animal or generally thinking about an animal could have motivated a higher likelihood of Anthropomorphic interpretations. This would not be the intended schema-based priming effect. The fact that this priming effect was replicated for readers but not for definers in Experiment 5 precludes such a nonschematic explanation. Here definers experienced the same difference in lexical content as did readers in corresponding Species conditions. Furthermore, the definition task required them to engage conceptually with the animal named in the compound. If the effects in Experiments 1-3 were due to generally thinking about an animal, we would expect Species to have a similar effect on definers. Neither lexical access nor nonschematic conceptual engagement can explain the significant interaction between Task and Species observed in Experiment 5.

Experiment 4 differed substantially from Experiments 1-3 in that following a Reading or Definition task, subjects provided interpretations for a list of 25 compounds. This was likely too cognitively demanding or distracting of a task to replicate the effect of Species found in Experiments 1-3 as neither this condition nor Task made any difference on the probability of an Anthro interpretation. It was noticed, however, that items which received higher rates of Anthro interpretations overall were more likely to prompt Anthro

interpretation rates in the predicted pattern with respect to Task and Species. This suggests that there is a certain baseline likelihood of Anthro interpretations that is required for the priming effect to emerge. This is not surprising considering that many factors presumably influence the likelihood of providing an Anthro interpretation of an Animal-Noun compound: people's personal experience with the animal and the noun; how often the animal is anthropomorphized; people's attitude toward the animal in general (perhaps animals people like are more likely to be anthropomorphized). In a flexible and dynamic schema view each of these factors would be represented schematically and we would expect a wide variety of schemas to constrain the construction of a schema in the process of understanding any novel compound. This baseline effect reflects the idea that abstract schemas must be integrated with more specific schemas in the construction of an interpretation of a novel compound. If there are fewer or weaker specific schemas consistent with an Anthro interpretation (as a low baseline rate would indicate) it would be more cognitively demanding and therefore less likely for an abstract schema to be integrated with these schemas in a way that motivates an Anthro interpretation.

In analysis of interpretations in Experiment 4 an additional potential confound was observed in the distinction between Entity and non-Entity interpretations. This raised the possibility that the successful priming in Experiments 1-3 was due to subjects simply being biased toward interpretations that involve an actual animal (entity) playing a role rather than being guided by a schema for how to integrate schemas of animals and human affairs. In the absence of competitive non-Anthro Entity interpretations this possibility could not be ruled out. Accordingly, Experiment 5 was designed to more carefully select experimental compounds which prompt for nontrivial amounts of both Anthro and non-

Anthro Entity interpretations. Additionally, Experiment 5 was designed to be more similar to Experiments 1-3 in that subjects interpreted only two compounds after each priming task. Under these more tightly controlled conditions, the predicted interaction between Task and Species was observed with readers more likely to provide Anthro interpretations in the Animal condition and with definers equally likely to between Animal conditions.

Because of the inclusion of a definition task, it seems implausible that the increased likelihood of Anthro interpretations observed for readers in the Animal condition was due to those subjects having thought about the animal named in the target compound or having recently read that lexical item. Notably, the opposite interaction was observed for non-Anthro Entity interpretations, excluding the possibility that the results from Experiments 1-3 and their replication in Experiment 5 are simply due to subjects being biased toward interpretations in which an animal plays a role as an entity holistically assumed by the interpretation. Experiment 5 thus provides strong evidence that schematic representations of conceptual knowledge is relied on and integrated in a way that resembles conceptual blending when people interpret novel NN compounds.

5.3 Chapter summary

The five experiments discussed in this chapter provide strong evidence for the human-centered schema view. The effects observed in Experiment 1, where three different Species conditions were used, demonstrate the relevance of nondichotomous category membership to schema theory. For a given schema, probabilistic knowledge of what kinds of entities typically fill certain roles constrains the likelihood of mapping a given entity onto that role. Subjects in the Lobster condition comprehended the passage by constructing a variety of

schemas in which lobsters are mapped onto roles typically filled by humans in everyday human activities. These mappings represent temporary alterations to schemas for lobsters and human activities.

These and the results in other experiments show that schema-based approaches to NN compound comprehension should view schemas as dynamic networks of probabilistic associations learned through experience. This contrasts with the slots and fillers approach of schema modification theory (Murphy 1988; 1990) and the augmented schema view (Wisniewski 1997) which more rigidly characterizes schemas as categorically containing or not containing certain slots.

The reading passages additionally differed in their degree of semantic connection to the head-noun in the target compound. On the semantically connected end of the spectrum there is Experiment 1, in which the priming passage mentions that the characters go shopping for clothes together and the target compound is *crab shirt*. On the other hand, the priming passage for *fish pencil* in Experiment 2 makes no mention of pencils, pens, writing, reading, school, or anything obviously connected to pencils semantically. The fact that comparable results happen in both situations suggests that schemas can be both abstract and specific. The specific schemas produced through conceptual blending in Animal conditions motivate a more abstract schema in which animals are more strongly associated with roles typically filled by humans in general.

The nonschematic relational approach of CARIN (Gagné & Shoben 1997) and RICE (Spalding et al. 2010; Gagné & Spalding 2013) cannot explain the results of these experiments. These theories posit that NN compounds are understood through first the selection of a general relation between the nouns and then, an elaboration of that relation

to a more specific conceptual combination. The insistence on the idea that the interpretation of NN compounds is simultaneously relation-based and nonschematic precludes these theories from incorporating general schematic conceptual knowledge from playing a role. As such, it is hard to imagine how relations, in the sense intended by these theories, would explain the patterns of Anthro interpretations produced in the experiments.

Using the restricted list of relations assumed in CARIN, we would analyze most of the Anthro interpretations of items that patterned as predicted in terms of either the USE or FOR relation: *crab shirt* as 'a shirt for/used by a crab'; *fish pencil* as 'a pencil for/used by a fish'; *bear gun* as 'a gun for/used by a bear'; *pig boot* as 'a boot for/used by a pig'; *rhino road* as 'a road for/used by rhinos'. CARIN and RICE claim that the likelihood of using a relation to interpret a novel NN compound is primarily motivated by the relational frequency of each constituent. In the experiments discussed here, relational frequency offers no explanation because no constituent of any experimental compound is used in a compound in any of the reading passages.

So CARIN and RICE's primary explanation for where interpretations of novel NN compounds come from has little to offer. Assuming that their posited relation-based mechanism is correct, we need some other explanation for how readers in the Animal condition were biased toward interpretations using the For or Use relation. The most obvious explanation is that subjects in this condition had just read about the animal named in the compound encountering objects that are For it or Used by it. This approach is problematic because not all target Anthro interpretations could be analyzed as a For or Use relation, such as *lion reconnaissance*, *cat theology*, and *bird routine*. It is not clear what single relation would characterize the Anthro interpretations of these compounds, though

they could all be analyzed semantically as situations where the animal named assumes an agentive role. This abstract notion of the doer within a given situation or event is of course schematic as well. First you need a concept of agency and second you need clear representation of different types of roles which are typically played in instances of the head noun.

In the human-centered schema view, both general and specific relations are represented schematically. Anthro interpretations can be explained in terms of the general schema of mapping an animal onto the human role in a schema and the specific schematic knowledge of the head noun. This made it possible to predict rates of a variety of specific interpretations, all of which share the general characteristic of animals playing human roles. Such predictions could not be made by CARIN or RICE because they assume that the selection of a general relation and elaboration to some specific meaning are different processes. Proponents of CARIN or RICE would then have to explain how someone goes from selecting a general For relation in interpreting *crab shirt* or *fish pencil* and then coming to the specific understanding that a *crab shirt* is a shirt that a crab WEARS and that a *fish pencil* is a pencil that a fish WRITES WITH. As the analysis in Chapter 4 demonstrated, the difficulty of such elaboration without the aid of schemas is a pervasive problem for CARIN and RICE. The human-centered schema view, on the other hand, allows interpretations to be guided by specific knowledge of SHIRT and PENCIL schemas, that they include roles of 'wearer' and 'writer' respectively and that these roles are typically filled by humans.

The five experiments discussed in this chapter demonstrate that conceptual schemas do play a role in NN compound interpretation and that these schemas are more flexible and

dynamic than characterized by the slots and fillers approach of either schema modification or the augmented schema view. The results are especially problematic for CARIN and RICE as no single relation could plausibly have biased subjects toward the target interpretations across different experimental compounds. Explaining the results of the experiments presented here would require contorting CARIN/RICE into something it claims not to be: reliant on schematic knowledge. The results of these experiments is best explained by a schema approach in which probabilistic knowledge of roles, relations, and co-occurrences are learned through experience and relied upon to understand language and form new concepts in a process consistent with the central claims of conceptual blending.

Chapter 6

Conclusion

This dissertation has demonstrated the necessity of incorporating schemas into any plausible account of noun-noun compounds. This demonstration was possible only by standing on a foundation of descriptive facts about NN compound meaning which has been uncovered through decades of research by linguists and psychologists. The meanings of most NN compounds can be paraphrased as one or more semantic relation between the two nouns, and a handful of relations account for the lion's share of these. These general relations, however, are not special to NN compounds. It is generally important to know where things are (Locative), how they bring about different states of affairs (Causative), why certain artifacts are created (Purpose), how specific things (Instruments) can be used to achieve different goals, and so on. What IS special about NN compounds is that the structure of compounding itself does not prompt us to select any relation in particular.

Plausible interpretations of novel compounds have to be inferred. Some sort of knowledge has to motivate our understanding of what sorts of scenarios can constitute plausible relations between two given nouns. This is where the explanatory advantages of schemas becomes obvious. Representing out structured knowledge of the kinds of situations and events we encounter in the world, schemas can guide the construction of a scenario in which the two nouns can plausibly be involved. But schemas represent much

more than the general relations that account for many NN compound meanings. They can holistically represent highly specific scenarios, which can include a variety of relations. This accounts for the fact that people's interpretations of novel compounds and their knowledge of many lexicalized compounds are often highly specific and involve more than a simple relation between the two nouns. And because schemas are the holistic representation of relations, they can treat as trivial cases those compounds which are reasonably well described in terms of a simple relation between nouns.

As the discussion in Section 2.3 demonstrated, because relational knowledge motivates NN compound meaning, rejecting schemas leads to a lack of internal validity. How can relations be represented if not schematically? In contrast, the human-centered schema view demonstrates that schemas not only account for NN compound meaning but serve as theoretical glue linking key insights from cognitive linguistics, sociology, cognitive psychology, and usage-based perspectives on language. This schema view enables us to more coherently consider the massively complex interactions of social, semantic, and grammatical knowledge that underlie NN compound comprehension. In this way, it is broadly consistent with what could be called the "cognitive linguistics view" in which meaning and grammar are intimately connected. Such a theoretical path, where we explicitly tie claims about NN compounds in with a broader perspective on concepts and language, is preferable. Alternatively, constructing a theory based on the peculiarities of NN compounds leaves too much room for inconsistency with other findings from research on language, mind, and society. Given the robust findings supporting the cognitive reality of schemas discussed in Chapter 3, theories such as CARIN (Gagné & Shoben 1997) and RICE (Spalding et al. 2010; Gagné & Spalding 2013) produce such an inconsistency. In

order to be accepted, they need to either explain how categorization, social reasoning, metaphor, and grammar can be accounted for without schemas or explain why understanding NN compounds would not depend on schematic knowledge while so many other aspects of cognition do.

Even if such theoretical requirements were met, the analysis of naturally occurring compounds in Chapter 4 demonstrates that NN compound meaning cannot be accounted for without schemas. More than a quarter of the transparent NN compounds taken from a random sample could not be explained without schemas, demonstrating that the problems are pervasive. Often a compound's meaning required associating the two noun concepts together with multiple relations. Selection of just one of these relations to motivate the compound meaning would be arbitrary and it is unclear how doing so would lead to an understanding that other relations are involved. Typically, specific schematic knowledge represented both relations, allowing a schema-based approach to easily account for the compound. In a processing model in which one relation is selected first, the other relation could only be inferred given such schematic knowledge. As an even greater problem for non-schema-based accounts of NN compounds, a number of compounds were not well paraphrased with a relation linking the nouns at all. Rather, the compounds were transparent because the two nouns each played a salient role within some specific schema.

Finally, experimental evidence provides support for the idea that abstract conceptual schemas are constructed in language comprehension and guide the disambiguation of novel NN compounds. This was accomplished by priming certain subjects with stories in which comprehension involved mapping animals onto roles in a variety of schemas which are typically filled by a human. In relation to subjects in the more conceptually "neutral"

definition task, target interpretations for readers primed in this way were much more likely. Similarly, subjects who read equivalent stories with human characters were less likely to provide target interpretations than subjects in the definition task. This suggests that the nonanthropomorphic interpretations were not default interpretations that had to be overridden. They were actively constructed just as the target anthropomorphic interpretations were. Such results are consistent with the claim of conceptual blending that understanding language involves constructing schemas by setting up mental spaces and actively linking elements across those spaces. This is similarly consistent with the dynamic view of schemas assumed by the human-schema view. Finally, the results of these experiments cannot be handled by nonschematic approaches because target interpretations for experimental items involved different general relations between nouns. There is no reason to think simple priming for a general semantic relation between the nouns could produce such results. The primed response rates corresponded to much more abstract mapping of animals onto particular roles within schematic knowledge of human activities.

The human-centered schema view, which explicitly demonstrates how schemas unite findings from cognitive and interactional linguistics, suggests new directions in NN compound research. The framework could be used to analyze novel compounds in context and generate hypotheses about how social and contextual factors interact with other knowledge to guide the comprehension process. For example, novel NN compounds appear to be quite common in humor. The different effects of humorous compounds and the apparent reliance on contextual information to produce those effects could motivate experiments seeking to capture more generalizable knowledge about how social knowledge guides comprehension of NN compounds. It might be less traditional to approach meaning

by asking how objective properties interact with intersubjective social knowledge to motivate utterance interpretation, but doing so would mirror work in sociophonetics which seeks to uncover the interactions between sociolinguistic knowledge and acoustic phonetic knowledge in speech perception (Thomas 2011). Given sociophoneticians' contributions to both sociolinguistic theory and speech perception, it would not be surprising to find that social knowledge is heavily relied upon in comprehension of ambiguous language such as NN compounds.

The tremendous explanatory breadth of schemas spans linguistic, psychological, and social phenomena. Both experimental and corpus data provide evidence that cannot be explained without appeal to the structured knowledge of things, scenarios, and events which schemas represent. Schemas therefore appear to be more than just a useful descriptive tool. Whether the human-centered approach proves to be the best theoretical route, schemas are clearly a necessary component of any psychologically valid account of NN compounds.

Appendix A

Sample of noun-noun compounds

This appendix contains the 724 noun-noun compounds that were considered for analysis following the sampling and filtering procedures described in Chapter 4. The frequencies of lemma pairings formed the basis of the sampling procedure. In most cases, the lemma pairing form was the same as its typical form in COCA. In some cases, however, a compound nearly always occurred with one or the other constituent in a plural form (for example, *admissions official* and *fashion pages*). The compounds have been listed to reflect the common forms they occur in rather than strictly their lemma form. In cases where the head noun occurred in singular and plural forms in a more balanced way, and the plural form did not create any particular change in meaning, the singular form is provided.

access number
accountability measures
action agenda
acuity score
admission official
adult inmate
adventure activities
advice column
age category
food standards
football season
forest elephant
fox fur
Fragrance Foundation
franchise owner
frequency spectrum
Fright Fest
fruit smoothie
proficiency level
program type
project architect
projection screen
prop stylist
property developer
prostitution ring
pumpkin cheesecake
pupil learning

agreement scores
aid community
air race
air wing
albacore tuna
alcohol dependency
A-list celebrity
aluminum industry
ammunition dump
anchor team
anger management
anniversary present
anxiety direction
AP course
appraisal amount
apron pocket
articulation test
assault force
attitude question
avoidance behavior
back pain
bamboo basket
banking reform
bar menu
beach towel
bean field
beauty tip
beefsteak tomato
beta weight
bike parking
biodiversity protection
fuel capacity
gambling debt
gasoline shortage
gender stereotype
genome sequence
gentleman farmer
geometry teacher
glass cabinet
glass painting
gold price
Golf Channel
government economist
government sector
grain harvest
graph theory
graphic design
groin strain
groove thing
ground beetle
group conversation
group hypermasculinity
group support
growth issue
guitar part
habitat loss
hall pass
hand mixer
hand rail
handball court
harbor area
head room
quartz crystal
quiz question
radio call
radio image
radio interview
railroad bridge
rain poncho
ranching community
range expansion
ratings game
reading chair
reading difficulty
reading environment
reconstruction plan
reference category
referent power
reform period
reform process
republican caucus
republican leadership
rescue organization
rescue vehicle
research attention
research variable
reservation office
resource availability
restaurant dinner
restaurant world
rice bran
rights fee
riot squad

bird lover
birth mom
birth pangs
blood plasma
boat basin
body fatness
bolt action
bond rating
bone tissue
brand marketing
breakfast burrito
brick kiln
broadcast journalism
broadcast signal
bronze bust
bug repellent
building entrance
bull horn
business conditions
business family
cab ride
cable line
cad data
calcium intake
calcium loss
call quality
camera angle
campaign contributor
cancer drug
candlelight vigil
Cannon Beach
health authority
health matters
heart beat
helicopter attack
hernia surgery
heroin dealer
high-school girl
hip dysplasia
hiring policy
history department
hockey coach
hockey team
home economist
home furnishings
home project
homicide division
hospice nurse
hospice team
host state
household size
housing assistance
housing industry
hunting ground
ice cave
image scale
implementation issues
import tax
industry interests
infant mortality
information policy
innovation policy
rivalry game
rock song
rod guide
role theory
roof overhang
routine procedure
rye bread
safety belt
safety factor
saliva sample
salmon habitat
sampling unit
satisfaction atonement
savant syndrome
savings bank
saw mill
school matters
school notebook
school song
school uniform
science department
science experiment
screen credit
sec tournament
sector fund
security cooperation
security crisis
security lapse
security law
Seminole tribe
senate hearing

canola oil
car length
carbon chain
career history
career track
carrier phrase
casualty insurance
CBO number
census results
certification program
chamomile tea
championship ring
cherry blossoms
chess team
child well-being
child witness
childhood history
chili dog
chip mills
chlorine level
Christmas dance
Christmas music
church lawn
church ministry
city limits
class material
clay pigeon
clothing business
clothing items
coach gun
coaching profession
inspection process
inspection team
instrument panel
insurance check
insurance payout
intelligence support
interest group
interrogation session
intervention efforts
intervention package
interview time
IOM criteria
iris scan
iron key
item content
jail house
jazz singer
Jets quarterback
job circumstances
journalism professor
juice glass
jury forewoman
killer storm
knife point
knit shirt
lady doctor
lake surface
lance corporal
land degradation
land mammal
land-use patterns
serum concentration
service women
sex selection
shelter program
shift work
shopping area
shopping spree
signature achievement
silk dress
silk kimono
size limit
skin aging
sky news
sleep research
slum clearance
sniff test
sniper attack
sodium bicarbonate
software house
soil structure
song dynasty
sophomore effort
sound technician
soup bone
soup bowl
space rock
specialty coffee
speech writer
speed bump
spending proposal
sperm production

coal reserves
coalition spokesman
coffee bean
college ball
color code
color temperature
color video
combat boot
combat role
comedy act
Commerce Club
committee chairwoman
committee system
commodity trading
communication apprehension
community participation
companion seat
compensation committee
computer kiosk
computer scientist
conference meeting
confirmation process
conflict management
construction paper
consumer items
consumer society
container port
contract price
control loop
convention delegates
conversion rate
launch cost
laundry hamper
learning target
leather booth
leather seat
lee side
Lego pieces
letter name
lettuce leaf
life extension
life need
life span
ligament damage
limestone floor
lip service
literacy proficiency
log flume
love poetry
love shack
lunch bucket
ma thesis
magnitude scale
marble pillar
marijuana business
market liberalization
market rent
market square
math question
mathematics classroom
meat hook
media business
sports clothes
sport fandom
sports journalist
sports shoes
spouse abuse
spring peeper
spy plane
stage clothes
stage mother
standard bearer
state economy
station platform
status level
steam room
steel alloy
stock fraud
stock number
stock report
stone facade
storage service
street agent
street thug
strength workout
strike activity
student beliefs
student musician
student researcher
study information
styling tip
subject pool
subscriber list

coping method
core identity
core temperature
corn pone
cost accounting
cotton field
counter stool
couples therapy
cover description
credibility markers
crime novel
crucifixion scene
Cubs catcher
curiosity shop
currency board
curriculum committee
curriculum goals
curriculum guide
dance contest
dance tune
dandruff shampoo
data gaps
dawn light
daytime soap
debt burden
deer woods
defense burden
defense posture
deficit financing
demonstration program
deputy administrator
media empire
media guide
media professional
mediation process
memory researcher
metal cart
metal sculpture
metal staircase
mid-afternoon snack
mill levy
miracle child
missile strike
mission program
monkey business
monsoon season
Morning Watch
motivation theory
mountain pasture
mouse brain
movement activity
multimedia installation
muscle activity
museum building
museum educators
music concepts
music listener
music technology
NAFTA panel
naming system
nativity play
navy man
subsistence activities
suede jacket
summary report
summer rates
support personnel
surface pressure
survey score
sustainability indicators
system standard
tablet form
talent show
talk radio
target audience
target market
tax levy
tax relief
t-cell response
teacher technology
teaching candidate
team identification
team learning
team turnovers
tech tools
telephone poll
telescope dome
television appearance
television lights
tenor sax
testing session
text complexity
thigh bone

descendant community
design element
design procedure
desktop version
diabetes medication
diet advice
disability coverage
disarmament agreement
disc jockey
disgust sensitivity
diversity lottery
divorce settlement
document examiner
door gunner
drafting table
drain line
drake equation
dress code
dresser drawer
drought relief
drug industry
drug scandal
drug suspect
drug unit
ecosystem processes
editing error
education approach
education market
electricity demand
elm street
e-mail server
nerve impulses
network model
news information
news junkie
nitrogen fixation
nose tackle
oak branch
observation note
occupation authority
odor complaint
office complex
offseason acquisition
opening night
option quarterback
oregano leaves
outlet center
oversight responsibility
oxygen supply
ozone concentration
pain perception
paint application
Palace Theater
panel review
paper cone
paper weight
papier mache
Paradise Lounge
parenting role
part owner
participant age
party operative
timber company
time allotment
tobacco money
toe ring
toilet training
tomato grower
tomato salsa
tournament golf
trade position
trade theory
trading floor
trailer hitch
transaction processing
transplant patient
transport company
transport route
transportation plan
trash bag
travel medicine
Treasury building
treasury yield
tree branch
trophy room
trump organization
trumpet call
tube pan
turkey vulture
turn shape
turning radius
Tuskegee Experiment
TV mom

embassy bombing
emergency team
employee behavior
energy conversion
environment minister
equipment maker
errand boy
error variance
ethics problem
ethics scandal
evaluation committee
evaluation system
event history
exit hole
expert review
export porcelain
eyewitness news
FAA inspector
factory owner
fall schedule
family atmosphere
family influence
family instability
family prayer
family satisfaction
family violence
farm operator
fashion house
fashion pages
feature debut
feedback effect
patent office
pathology department
patronage network
peak torque
peasant girl
pension asset
performance accuracy
personnel evaluation
pesticide levels
pet bird
pet ownership
philosophy class
phone log
physics experiment
physics lab
pickle barrel
picnic table
pier glass
pincer movement
planning staff
plant ecologist
plant introduction
plant productivity
plant species
plastic plate
plumbing pipe
police power
policy coordination
pool play
pool table
population fluctuations
twitter feed
university endowment
USB drive
vacation home
vacation resort
validity issue
vegetable peeler
vein thrombosis
video sequence
voice range
voice recording
voting age
waffle maker
waist height
waiver program
walking papers
wallpaper paste
war president
warning letter
waste recycling
water bowl
watercress sprigs
weapons plant
weapons project
weekend series
welfare state
wind damage
wind farm
wire brush
wire story
women lawyer

feeder school
fennel salad
fertility issues
fighting weight
film community
finger paint
fire deaths
flannel trousers
flop shot
flower arrangement
flower garden
flower pattern
flower stalk
fluid buildup
food crops
Food Lion
population survey
portrait studio
poverty problem
power boat
power conversion
power politics
practice efficiency
practice plan
precision bombing
prestige scores
Price Club
priority area
probability assessment
process step
production cost
wood finish
wood flooring
wool stockings
wool suit
world marketplace
world organization
wrestling championship
wrinkle cream
wrist band
writing career
x-ray satellite
yard work
yogurt mixture
zone system
zucchini flower

Appendix B

Experiment 1 materials

This appendix provides the reading passages used as primes in Experiment 1. Within parentheses and in bold the differences between conditions are provided separated by a slash in order from Human to Penguin to Lobster. All subjects subsequently provided an interpretation for the compound *crab shirt*.

Michael and Alice are **(good friends / two penguins / two lobsters)** who have known each other since they were little. They went to school together, played sports together, and after college traveled around the world together. After all that time, they still enjoy each other's company. On weekends they often do yoga or go to the beach.

As luck would have it, Michael and Alice even get to spend their weekdays together since they work in the same law office **(near / near / in)** the bay. Though they thrive on the intellectual challenge of their jobs, they despise the formal attire required. They are both casual people and would usually prefer to be at home lounging in their pajamas than trying to impress a client with newly minted suits. But, since their jobs require them to dress formally and since they know each other quite well, they often make the chore of buying work clothes less painful by shopping together. When they succeed at finding inexpensive outfits, they reward themselves by stopping by their favorite store, Seashore Styles, where they can usually find clothes that better represent their personalities.

Appendix C

Experiment 2 materials

This appendix provides the materials used in Experiment 2. Each compound interpreted is given in italics followed by the reading passage which preceded it in the experiment. In bold and within parentheses, differences between Human and Animal conditions are given, separated by a forward slash. The Human condition version is given before the Animal condition version. Where there is no content on one side of a bold slash within parentheses, this indicates that in the corresponding condition the content on the other side of the slash was simply absent. The filler compound and reading passage are included at the end. The reading comprehension question which all subjects encountered at the end of the experiment is given at the end in italics.

fish pencil

Beatrix and Amanda are **(friends / two fish)** who have known each other a long time. After finishing dinner at their favorite restaurant, Amanda says "Whew, those were some good **(crawfish / minnows)**! I'm gonna slip outside for a smoke."

"Oh. I thought you quit smoking?"

"Yeah I did, but-"

"You know, I'm really worried about you, Amanda. Didn't your doctor say there's no way you'll get your blood pressure down if you don't stop smoking?"

"Yeah, she did. She did. But I'm actually doing really well! Each time I quit I go longer without a cigarette."

"That's not how ‘quitting’ works," says Beatrix.

"I know. Okay, look. This is the last one, I promise. Here, take the rest." Amanda takes a cigarette and tosses the remainder of the pack on the table in front of Beatrix, who looks at the pack uncomfortably.

"I promise I'll go at least a month without smoking after this one."

"Okay," replies Beatrix skeptically.

Amanda quickly exits. Watching strangers **(walk / swim)** by, she puts the cigarette between her lips, lights it with a match, and smiles while exhaling the tobacco smoke for one of the last times.

crab shirt

Michael and Alice are **(good friends / two crabs)** who have known each other since they were little. They went to school together, played sports together, and after college traveled around the world together. After all that time, they still enjoy each other's company. On weekends they often do yoga or go to the beach.

As luck would have it, Michael and Alice even get to spend their weekdays together since they work in the same law office **(near / in)** the bay. Though they thrive on the intellectual challenge of their jobs, they despise the required wardrobe. Since their jobs require them to dress formally and since they know each other quite well, they often make the chore of buying work clothes less painful by shopping together.

bear gun

Jack and Janice are **(friends / two bears)** who live in the same neighborhood. On a walk, they bump into each other.

"Hi Janice, how are the **(kids / cubs)**?"

"Great, great. They're growing really fast **(though /)**. We can hardly get enough **(food / fish)** to feed 'em!"

"Haha, wow!"

"You know, Jarvis is already **(32 inches long / 200 pounds)**!?"

"That's a fast growing **(boy / bear)**. And he's what, 10 months old?"

"Yep, just 10 months."

"Wow, I don't think any of mine were that big even at a year old. But then again, we're a pretty small family...Oh by the way, I heard y'all went to Colorado last summer. How was that?"

"It was great! We went hiking and fishing every day and got to stay in a cabin with a beautiful view."

"Sounds like fun...Whelp, I gotta get going."

"Okay, take care."

"See ya."

goat barbecue

Steve and Juan are **(roommates / two goats)** who share a new apartment downtown. They live together because rent is just too high to go without a roommate.

"Man, I love my new car," said Steve. "It's so much fun to drive! It might not be particularly big or sporty but it hugs the turns real well and gets up to speed surprisingly fast!."

Juan flips through the channels. "Did it come with a spare tire? You know there's this new trend where cars don't come with spare tires and you have to shell out some extra dough if you want one."

"Yeah I've heard about that. But no that wasn't a problem. It came with the standard five tires."

Steve walks to the **(kitchen / corner)** and takes a huge bite out of **(his salad / their house plant)**. "Hey, doesn't that new documentary about the Inca air tonight," he asks with a mouth full of leaves.

"I guess so," Juan replies, keeping his eyes glued to the TV. "Do you want me to put it on?"

"Yeah sure! Unless you wanted to watch something else."

"No, that's fine." Juan fumbles with the remote and changes the channel.

stool record (Filler)

Terrance and Felix work together at a restaurant. Terrance works in the kitchen and Felix waits tables. It's a good thing they work in different spaces in the restaurant because they don't get along very well. Though Terrance's prolific moodiness has earned him the nickname "Testy T", you could really say it's Felix's fault that they have so many arguments. He can seem perfectly at ease and then suddenly, he blows up at his co-workers over nothing.

One time, Terrance forgot to substitute a salad for fries on an order that Felix was serving. The customers didn't mind much and politely pointed out the error. But once Felix made his way to the kitchen you'd think Terrance had put a side of excrement on the plate.

"What's wrong with you!?" screamed Felix. "I wrote 'salad' on the order. See, it says it right here. S-A-L-A-D! Can you not read? Or do you just not know what salads are? It's a collection of these little green things!" Felix grabbed a fistful of spinach leaves and threw them at Greg, storming out of the kitchen and quickly putting on a fake smile for the customers.

In the passage about the restaurant workers, why did Felix get so mad at Terrance?

Appendix D

Experiment 3 materials

This appendix provides the materials used in Experiment 3. Each compound interpreted is given in italics followed by the reading passage which preceded it in the experiment. In bold and within parentheses, differences between Human and Animal conditions are given, separated by a forward slash. The Human condition version is given before the Animal condition version. The filler compound and reading passage are included at the end. The reading comprehension question which all subjects encountered at the end of the experiment is given at the end in italics.

bear gun

Beatrix and Amanda are **(friends / two bears)** who have known each other a long time. After finishing dinner at their favorite restaurant, Amanda says "Whew, those were some good **(crawfish / fish)**! I'm gonna slip outside for a smoke."

"Oh. I thought you quit smoking?"

"Yeah I did, but-"

"You know, I'm really worried about you, Amanda. Didn't your doctor say there's no way you'll get your blood pressure down if you don't stop smoking?"

"Yeah, she did. She did. But I'm actually doing really well! Each time I quit I go longer without a cigarette."

"That's not how ‘quitting’ works," says Beatrix.

"I know. Okay, look. This is the last one, I promise. Here, take the rest." Amanda takes a cigarette and tosses the remainder of the pack on the table in front of Beatrix, who looks at the pack uncomfortably.

"I promise I'll go at least a month without smoking after this one."

"Okay," replies Beatrix skeptically.

Amanda quickly exits. Watching strangers **(walk / saunter)** by, she puts the cigarette between her lips, lights it with a match, and smiles while exhaling the tobacco smoke for one of the last times.

crab shirt

Michael and Alice are **(good friends / two crabs)** who have known each other since they were little. They went to school together, played sports together, and after college traveled around the world together. After all that time, they still enjoy each other's company. On weekends they often do yoga or go to the beach.

As luck would have it, Michael and Alice even get to spend their weekdays together since they work in the same law office **(near / in)** the bay. Though they thrive on the intellectual challenge of their jobs, they despise the required wardrobe. Since their jobs require them to dress formally and since they know each other quite well, they often make the chore of buying work clothes less painful by shopping together.

stool record (Filler)

Terrance and Felix work together at a restaurant. Terrance works in the kitchen and Felix waits tables. It’s a good thing they work in different spaces in the restaurant because they don’t get along very well. Though Terrance’s prolific moodiness has earned him the nickname “Testy T", you could really say it’s Felix’s fault that they have so many arguments. He can seem perfectly at ease and then suddenly, he blows up at his co-workers over nothing.

One time, Terrance forgot to substitute a salad for fries on an order that Felix was serving. The customers didn’t mind much and politely pointed out the error. But once Felix made his way to the kitchen you’d think Terrance had put a side of excrement on the plate.

“What’s wrong with you!?” screamed Felix. “I wrote ‘salad’ on the order. See, it says it right here. S-A-L-A-D! Can you not read? Or do you just not know what salads are? It’s a collection of these little green things!” Felix grabbed a fistful of spinach leaves and threw them at Greg, storming out of the kitchen and quickly putting on a fake smile for the customers.

In the passage about the restaurant workers, why did Felix get so mad at Terrance?

Appendix E

Experiment 4 materials

This appendix provides the materials used in Experiment 4. The two reading passages are given with differences between Human and Animal conditions in bold and within parentheses, separated by a forward slash. The Human condition version is given before the Animal condition version. The respective words defined in the definition task are underlined. The two lists of compounds are given with experimental items underlined in Table E.1. The reading comprehension question which all subjects encountered at the end of the experiment is given at the end in italics.

Passage 1

Beatrix and Amanda are **(friends / two fish)** who have known each other a long time. After finishing dinner at their favorite restaurant, Amanda says "Whew, those were some good **(crawfish / minnows)**! I'm gonna slip outside for a smoke."

"Oh. I thought you quit smoking?"

"Yeah I did, but-"

"You know, I'm really worried about you, Amanda. Didn't your doctor say there's no way you'll get your blood pressure down if you don't stop smoking?"

"Yeah, she did. She did. But I'm actually doing really well! Each time I quit I go longer without a cigarette."

"That's not how ‘quitting’ works," says Beatrix.

"I know. Okay, look. This is the last one, I promise. Here, take the rest," Amanda takes a cigarette and tosses the remainder of the pack onto the table in front of Beatrix, who looks at the pack uncomfortably.

"Or … I'll go at least a month without smoking after this one," Amanda bargains.

"Okay," replies Beatrix skeptically.

Amanda quickly exits. Watching strangers **(walk / swim)** by, she puts the cigarette between her lips, lights it with a match, and smiles while exhaling the tobacco smoke for perhaps one of the last times.

Passage 2

Steve and Juan are **(friends / two goats)** who share an apartment downtown. They live together because rent is just too high to go without a roommate.

"Man, I love my new car," said Steve. "It's so much fun to drive! It might not be particularly big or sporty but it hugs the turns real good and gets up to speed surprisingly fast!."

Juan flips through the channels. "Did it come with a spare tire? You know there's this new trend where cars don't come with spare tires and you have to shell out some extra dough if you want one."

"Yeah I've heard about that. But no that wasn't a problem. It came with the standard five tires."

Steve walks to the corner and takes a huge bite out of **(his salad / their house plant)**. "Hey, doesn't that new documentary about the Inca air tonight?" he asks with a mouth full of leaves.

"I guess so," Juan replies, keeping his eyes glued to the TV. "Do you want me to put it on?"

"Yeah sure! Unless you wanted to watch something else."

"No, that's fine." Juan fumbles with the remote and changes the channel.

LIST 1	LIST 2
cloud disappointment	*mountain television*
tank net	*crab outrage*

sand surgery	*curtain flower*
chair discussion	*tree glove*
turtle truck	*tornado pie*
juice cotton	*frog television*
plate tree	*truck grass*
grass razor	*politics pig*
hawk hat	*truck ant*
pig deer	*elephant snake*
boat cloud	*rhino shark*
discussion road	*lizard game*
silk joy	*net bottle*
turtle robin	*truck belief*
squid sheep	*squirrel bottle*
concert plate	*boat snake*
meeting bucket	*wallet water*
shark razor	*graffiti glass*
knife crab	*juice surgery*
elephant meeting	*joy dirt*
bottle hawk	*octopus hawk*
coal chandelier	*herb steel*
amusement shark	*surgery podium*
sheep amusement	*river shoe*
hat bed	*wolf pencil*

Table E.1 Compound lists used in Experiment 4. Experimental compounds are underlined.

In the first passage, why was Amanda upset with Beatrix?

Appendix F

Experiment 5 materials

This appendix provides the materials used in Experiment 5. Pairs of compounds are given in italics followed by the reading passage which preceded them in the experiment. Experimental compounds are underlined. Filler items are indicated in parentheses. Differences between Human and Animal conditions for the passages are in bold and within parentheses, separated by a forward slash. The Human condition version is given before the Animal condition version. The respective words defined in the definition task are underlined. If the word is inflected but only the stem is underlined (e.g., pigs, chases), then the stem was used in the definition task. For Filler 2 and Filler 4, the respective reading comprehension question that followed each item is given in italics between the pair of compounds and the reading passage.

routine maze, pig boot

Steve and Juan are two **(friends / pigs)** who share an apartment downtown. They get along fine but really only live together because rent is too high to go without a roommate.

"Man, I love my new car," says Steve. "It's so much fun to drive! It might not be particularly big or sporty but it hugs the turns real well and gets up to speed surprisingly fast!"

Juan flips through the channels. "Did it come with a spare tire? You know there's this new trend where cars don't come with spare tires and you have to shell out some extra dough if you want one."

"Yeah I've heard about that. But no that wasn't a problem. It came with the standard five tires."

Steve walks into the kitchen and takes a huge bite out of his salad. "Hey, doesn't that new documentary about the Inca air tonight?" he asks with a mouthful of leaves.

"I guess so," Juan replies, keeping his eyes glued to the TV. "Do you want me to put it on?"

"Yeah sure! Unless you wanted to watch something else."

"No, that's fine." Juan fumbles with the remote and changes the channel.

basket delivery, cat theology

Monica and Anusha are **(friends / cats)** who have known each other a long time. After finishing dinner at their favorite restaurant, Anusha says "Whew, that was some good tuna! I'm gonna slip outside for a smoke."

"Oh. I thought you quit smoking?"

"Yeah I did, but-"

"You know, I'm really worried about you, Anusha. Didn't your doctor say there's no way you'll get your blood pressure down if you don't stop smoking?"

"Yeah, she did. She did. But I'm actually doing really well! Each time I quit I go longer without a cigarette."

"That's not how 'quitting' works," says Monica.

"I know. Okay, look. This is the last one, I promise. Here, take the rest." Anusha takes out a cigarette and tosses the remainder of the pack on the table in front of Monica, who looks at the pack uncomfortably.

"I promise I'll go at least a month without smoking after this one."

"Okay," replies Monica skeptically.

Anusha quickly exits. As a few dogs saunter by, she puts the cigarette between her lips, lights it with a match, and smiles while exhaling the tobacco smoke for one of the last times.

horse boss, glasses music

Miguel and Alex are a couple of recently retired, middle-aged **(horses / men)** who spent the previous 25 years working together. They like to go canoeing and camping in the fall when it gets cool at night but the water is still relatively warm. Poking the campfire with a stick, Alex says "Fire seems ready. Get me those marshmallows would you?"

Miguel hollers "Yep!" and grabs the bag of marshmallows from the cab of the truck. He walks over to the fire and drops them next to Alex.

Alex tears into the bag, pauses, and looks wistfully into the woods. "You know I haven't toasted marshmallows in like a million years? I think this retirement thing's gonna be a pretty good gig."

"Yeah. Sure beats getting up at the crack of dawn just to sit in front of a computer screen all day." Miguel pulls a flask out of his jacket pocket and takes a sip. "But I do wonder what I'm gonna do with all this extra time."

Alex smiles and says, "Well I guess we better start collecting old people hobbies. Bingo, C-SPAN, wood whittling…"

Miguel winces and laughs artificially. "Yeah…right."

lion reconnaissance, chore loan

Leah and Jason are precocious **(kids / lions)** who walk home from school together. One day on their way home, Jason asks, "Why do you think Mr. Chadwick gets so mad all the time?"

Leah adjusts her bag which is loaded with books. "I don't know, but it's kind of funny. All he does is scream but he never really does anything else. And his face turns totally red!"

"Yeah it doesn't really make sense. I've seen him at basketball games with his family and he seems totally happy."

"Yeah, and my brother told me that when he had him, he started crying on the last day of class, saying how much he enjoyed teaching their class that year. So it's not like he hates his job or students or-"

Leah sees a pigeon on the sidewalk and puts her bag down. She crouches sneakily then chases after it, but it notices her and escapes just in time.

"Almost got it!" shouts Jason.

Leah runs back to her bag and picks it up. “Anyway, yeah my mom says that some teachers just have a few loose screws and get mad for no reason. I guess that’s all it is.”

“Yeah, I guess so.”

addiction glasses, bird routine

Paul and Francesca are a pair of colorful **(musicians / birds)** who write songs together and perform as a duo called “Pfff”. Despite their flippant stage name, they take their work very seriously. As Francesca sits tweaking sounds on her synthesizer, Paul enters the room and trips on some instrument cables. He dramatically and deliberately falls onto his back.

Francesca laughs and says, “Well that’s one way to make an entrance. You should come on stage like that.”

Paul grabs an unplugged microphone and starts singing, “Iiiii am so smooth / smooth like the … moon / I ennnter the room / they scaaaatter and swoon.”

“Haha. It’s a good thing we write the lyrics ahead of time. Speaking of writing, I’ve got some ideas for that song we were working on the other day. Check this sound out.” She presses a couple buttons, turns a few knobs and then plays a cascading melody with a whirring sound coming out of the speaker.

“Woah! That’s aggressive.”

“Yeah, but play your part.”

Paul plugs in his guitar and starts playing through a chord progression. Francesca plays the synth melody again. They keep playing and Paul starts to smile.

rhino road, reconnaissance theology

Beatrix and Amanda are friendly but competitive **(athletes / rhinos)** who play basketball at the gym on the weekends. They played together in high school, so they know each other’s game inside and out. Despite their equal knowledge, Beatrix usually wins because she’s simply faster than Amanda.

Beatrix fakes right and crosses over to the left, speeding past Amanda to make an easy layup. “Aaaah, good game,” says Amanda. “Wanna play one more?”

Beatrix looks at her phone. “No, I gotta go in just a few minutes. My parents are coming to town this weekend so I have to clean up a bit.”

Amanda looks up while unlacing her shoes. “Oh cool. Is this their first time back since moving to Montana?”

“Second actually, though the first time wasn’t really a planned visit. They just stopped by for a few hours on their way to Houston. We ate at Nick’s.”

“How have they liked it up there?” Amanda asks while pulling a pair of flip flops out of her gym bag.

“They seem really happy. Of course my mom grew up there, so it’s no surprise she’s loving it.”

“Yeah I guess not. Well tell them I said ‘hi’.”

“Will do.”

kitchen reconnaissance, victory boss (Filler 1)

Bill and Janet each get a weekly allowance of two dollars. Their parents often tell them not to spend it all in one place. After saving for a month, they head to the arcade with no intention of following that advice.

“What games are you gonna play today?” Janet asks Bill while kicking a rock down the street.

“Definitely Raceville 2000. Probably Toady. I’m getting close to the highest score on that one.”

“Yeah, I’m gonna play Toady too.”

“Have you even gotten past the second boss yet!?” Bill says with a big smirk on his face.

Janet glares at Bill for a second and then punches him in the arm.

Bill stumbles away, holding his arm and laughing. “Oh come on. You’ll get better. Just watch me to see how it’s done.”

“God, you’re stupid,” Janet mutters while rolling her eyes.

A few minutes later they turn the corner onto the street the arcade is on. Janet looks up in confusion saying “What the…”

A crowd is gathered across the street from the arcade, watching smoke billow out of it.

Bill shrugs and says, “Well there goes that plan.”

disease garbage, delivery job (Filler 2)

Where do Lacey and Alicia work?

Lacey and Alicia work for the postal service, sorting packages and envelopes that are not successfully sorted by machine. They are also on a bowling team called Postal Strike.

Lacey stands holding a small package with a confused look on her face. “Where do you think this is supposed to be going? It looks like the town is called…Vertigo? And the state and the zip code are really unclear.”

Alicia walks over and takes a look. “Hahaha, I’ve never seen writing like that. Seriously, is that supposed to be Arkansas? Or Arizona?”

“I have no idea.” Lacey places the package in a bin with other indecipherable addresses.

Alicia grabs a stack of envelopes. “So you know Omar can’t come to the game tonight against Spares and Strikes Forever. Do you think your dad can fill in for him?”

“Yeah maybe. But his back was acting up again recently so maybe not. I’ll ask him.” Lacey pulls out her phone to text her dad and notices the time. “Hey it’s already five o’clock.”

“Wow this day went by fast.” Alicia grabs her coat and heads for the door. “See you in a few hours.”

“See ya.”

music desk, garage clothes (Filler 3)

Dave and his son Winston live in a town on the coast. On weekends they volunteer with an organization that cleans up trash in public spaces.

“I’ve never seen so many beer cans out here before,” Dave says while emptying out a can full of sea water and placing it in a bag.

“Did there used to be this much trash on the beach? Or is this a new problem?” Winston asks while examining a conch shell.

“No it’s not new. I remember coming here with Pawpaw when I was little. We’d drink sodas and just leave the glass bottles out.”

“Really!?”

"Yeah, but things were different then. People were just starting to understand littering and the environment."

Winston spots something glimmering in the sand and runs over to it. "It's a ring, dad!" He picks it up and runs back to his dad. "Is it a diamond?"

"I don't know." Dave holds the ring up and removes his glasses so he can see it better. "Haha, no. I think this is just costume jewelry. Want it?"

"No, you can have it."

"Oh okay, thanks." Dave puts it into his trash bag and keeps walking.

career device, road beard (Filler 4)

Why was Felix angry at Sasha?

Sasha and Felix work together at a restaurant. Sasha works in the kitchen and Felix waits tables. It's a good thing they work in different parts the restaurant because they don't get along. Really, Felix is more to blame though. He can seem perfectly at ease and then suddenly blow up at his co-workers over nothing.

Felix barges into the kitchen and angrily drops a plate onto a cutting board. "What on earth do you think this is?" he exclaims at Sasha.

"Looks like a burger and fries to me."

"Yeah and what does this say right here?" Felix demands while shoving the ticket in her face.

"Oh my bad. Should be a salad. I'll fix it."

"Yeah, that's right!" Felix screams. "Salad, just as I wrote it. S-A-L-A-D! Can you not read? Or do you just not know what salads are? It's a collection of these little green things!" Felix grabs a fistful of spinach leaves and throws them at Sasha, storming out of the kitchen and quickly putting on a fake smile for the customers.

Used to such childish outbursts, Sasha just looks at a co-worker and shrugs.

REFERENCES

BAKHTIN, MIKHAIL M. 1986. *Speech genres and other late essays.* Austin: University of Texas Press.

BARSALOU, LAWRENCE W. 1999. Perceptual symbol systems. *Behavioral and Brain Sciences* 22.577-660.

BATES, DOUGLAS, MARTIN MAECHLER, BEN BOLKER, AND STEVE WALKER. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67.1-48.

BENCZES, REKA. 2006. *Creative compounding in English: The semantics of metaphorical and metonymical noun-noun combinations.* Amsterdam: John Benjamins.

BERGEN, BENJAMIN. 2012. *Louder than words: The new science of how the mind makes meaning*. New York: Basic Books.

BORODITSKY, LERA, AND MICHAEL RAMSCAR. 2002. The roles of body and mind in abstract thought. *Psychological Science* 13.185-9.

BURNARD, LOU. 2000. *Reference guide for the British National Corpus* (world edition). Oxford: Oxford University Computing Services.

CHOMSKY, NOAM. 1957. *Syntactic structures*. The Hague: Mouton.

COSTELLO, FINTAN J., AND MARK T. KEANE. 2000. Efficient creativity: Constraint-guided conceptual combination. *Cognitive Science*. 24.299-349.

COULSON, SEANA, AND TEENIE MATLOCK. 2001. Metaphor and the space structuring model. *Metaphor and Symbol* 16.295-316.

DAVIES, MARK. (2008-). The Corpus of Contemporary American English (COCA): 520 million words, 1990-present. Online: https://corpus.byu.edu/coca/.

DOWNING, PAMELA. 1977. On the creation and use of English compound nouns. *Language* 53.810-42.

ESTES, ZACHARY. 2003. Attributive and relational processes in nominal combination. *Journal of Memory and Language* 48.304-19.

FAUCONNIER, GILLES. 1994. *Mental spaces: Aspects of meaning construction in natural language*. New York: Cambridge University Press.

FAUCONNIER, GILLES, AND MARK TURNER. 1998. Conceptual integration networks. *Cognitive Science* 22.133-87.

FAUCONNIER, GILLES, AND MARK TURNER. 2002. *The way we think: Conceptual blending the mind's hidden complexities*. New York: Basic Books.

FERREIRA, FERNANDA, KARL G.D. BAILEY, AND VITTORIA FERRARO. 2002. Good-enough representations in language comprehension. *Current Directions in Psychological Science* 11.11-15.

FERREIRA, FERNANDA. 2003. The misinterpretation of noncanonical sentences. *Cognitive Psychology* 47.164-203.

FERREIRA, FERNANDA, AND NIKOLE D. PATSON. 2007. The 'good enough' approach to language comprehension. *Language and Linguistics Compass* 1.71-83.

FILLMORE, CHARLES J. 1982. Frame semantics. *Linguistics in the Morning Calm*, ed. by Linguistics Society of Korea, 11-37. Seoul: Hanshin.

FILLMORE, CHARLES J., PAUL KAY, AND MARY CATHERINE O'CONNOR. 1988. Regularity and idiomaticity in grammatical constructions: The case of let alone. *Language*. 64.501-38.

GAGNÉ, CHRISTINA L. 2000. Relation-based combinations versus property-based combinations: A test of the CARIN theory and the dual-process theory of conceptual combination. *Journal of Memory and Language* 42.365-89.

GAGNÉ, CHRISTINA L. 2001. Relation and lexical priming during the interpretation of noun-noun combinations. *Journal of Experimental Psychology*: *Learning, Memory, and Cognition*. 27.236-54.

GAGNÉ, CHRISTINA L. 2002. Lexical and relational influences on the processing of novel compounds. *Brain and Language* 81.723-35.

GAGNÉ, CHRISTINA L., AND EDWARD J. SHOBEN. 1997. Influence of thematic relations on the comprehension of modifier-noun combinations. *Journal of Experimental Psychology* 23.71-87.

GAGNÉ, CHRISTINA L., AND THOMAS L. SPALDING. 2004. Effect of relation availability on the interpretation and access of familiar noun-noun compounds. *Brain and Language* 90.478-86.

GAGNÉ, CHRISTINA L., AND THOMAS L. SPALDING. 2009. Constituent integration during the

processing of compound words: Does it involve the use of relational structures? *Journal of Memory and Language* 60.20-35.

GAGNÉ, CHRISTINA L., AND THOMAS L. SPALDING. 2013. Conceptual composition: The role of relational competition in the comprehension of modifier-noun phrases and noun-noun compounds. *Psychology of Learning and Motivation* 59.97-130.

GAGNÉ, CHRISTINA L., THOMAS L. SPALDING, AND HONGBO JI. 2005a. Re-examining evidence for the use of independent relational representations during conceptual combination. *Journal of Memory and Lanuage* 53.445-55.

GAGNÉ, CHRISTINA L., THOMAS L. SPALDING, AND MELISSA C. GORRIE. 2005b. Sentential context and the interpretation of familiar open-compounds and novel modifier-noun phrases. *Language and Speech*. 48.203-21.

GIBBS, RAYMOND W. 1979. Contextual effects in understanding indirect requests. *Discourse Processes* 2.1-10.

GIBBS, RAYMOND W. 1983. Do people always process the literal meanings of indirect requests? *Journal of Experimental Psychology: Learning Memory, and Cognition* 9.524-33.

GIBSON, JAMES J. 1977. The theory of affordances. *Perceiving, acting, and knowing: toward an ecological psychology*, ed. by Robert Shaw and John Bransford, 67-82. Hoboken: John Wiley & Sons.

GOLDBERG, ADELE. 1995. *Constructions: A construction grammar approach to argument structure.* Chicago: Chicago University Press.

GRICE, PAUL. 1975. Logic and conversation. *Syntax and semantics, vol. 3: Speech acts*, ed. by P. Cole and J. Morgan, 43-58. New York: Academic Press.

GUMPERZ, JOHN J. 1993. Culture and conversational inference. *The role of theory in language description*, ed. by W. Foley, 193-214. New York: Mouton de Gruyter.

HATCHER, ANNA G. 1960. An introduction to the analysis of English noun compounds. *Word* 16.356-73.

HOPPER, PAUL J. 1987. Emergent grammar. *BLS* 13:139-157.

HYMES, DELL. 1962. The ethnography of speaking. *Anthropology and human behavior*, ed. by T. Gladwin and W. Sturtevant, 13-53. Washington D.C.: The Anthropological Society of Washington.

ISBERNER, MAJ-BRITT, AND TOBIAS RICHTER. 2013. Can readers ignore implausibility? Evidence for nonstrategic monitoring of event-based plausibility in language

comprehension. *Acta Psychologica* 142.15-22.

JESPERSON, OTTO. 1954. *A modern English grammar on historical principles. Part VI. Morphology*. London: George Allen & Unwin.

JI, HONGBO, CHRISTINA L. GAGNÉ, AND THOMAS L. SPALDING. 2011. Benefits and costs of lexical decomposition and semantic integration during the processing of transparent and opaque English compounds. *Journal of Memory and Language* 65.406-30.

JOHNSON, MARK. 1987. *The body in the mind: The bodily basis of meaning, imagination, and reason.* Chicago: University of Chicago Press.

LABOV, WILLIAM. 1973. The boundaries of words and their meanings. *New ways of analyzing variation in English,* ed. by Charles-James N. Bailey and Roger W. Shuy, 340-373. Washington D.C.: Georgetown University Press.

LAKOFF, GEORGE. 1987. *Women, fire, and dangerous things*. Chicago: University of Chicago Press.

LAKOFF, GEORGE, AND MARK JOHNSON. 1980. *Metaphors we live by*. Chicago: University of Chicago Press.

LAKOFF, GEORGE, AND MARK JOHNSON. 1999. *Philosophy in the flesh: The embodied mind and its challenge to Western thought.* New York: Basic Books.

LANGACKER, RONALD W. 1987. *Foundations of cognitive grammar. Volume I: Theoretical prerequisites*. Stanford: Stanford University Press.

LANGACKER, RONALD W. 1991. *Concept, image, and symbol: The cognitive basis of grammar*. Berlin: Mouton de Gruyter.

LANGACKER, RONALD W. 2008. *Cognitive grammar: A basic sintroduction*. Oxford: Oxford University Press.

LEES, ROBERT B. 1963. *The grammar of English nominalizations*. Bloomington: Indiana University.

LEVI, JUDITH N. 1975. The syntax and semantics of non-predicating adjectives in English. University of Chicago dissertation.

LEVI, JUDITH N. 1978. *The syntax and semantics of complex nominals*. New York: Academic Press.

LI, CHARLES. 1971. Semantics and the structure of compounds in Chinese. University of California, Berkeley, ms.

LYNOTT, DERMOT, AND LOUISE CONNELL. 2010a. The effect of prosody on conceptual combination. *Cognitive Science* 34.1107-23.

LYNOTT, DERMOT, AND LOUISE CONNELL. 2010b. Embodied conceptual combination. *Frontiers in Psychology* 1:212.1-14.

MAGUIRE, PHIL, BARRY DEVERUX, FINTAN COSTELLO, AND ARTHUR CATER. 2007. A reanalysis of the CARIN theory of conceptual combination. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 33.811-21.

MARCHAND, HANS. 1960. *The categories and types of present-day English word-formation*. Wiesbaden: Otto Harrassowitz.

MATSUKI, KAZUNAGA, TRACY CHOW, MARY HARE, JEFFREY L. ELMAN, CHRISTOPH SCHEEPERS, AND KEN MCRAE. 2011. Event-based plausibility immediately influences on-line language comprehension. *Journal of Experimental Psychology. Learning, Memory, and Cognition* 37.913-34.

MURPHY, GREGORY L. 1988. Comprehending complex concepts. *Cognitive Science* 12.529-62.

MURPHY, GREGORY L. 1990. Noun phrase interpretation and conceptual combination. *Journal of Memory and Cognition* 29.259-88.

MURPHY, GREGORY L., AND EDWARD J. WISNIEWSKI. 2006. Familiarity and plausibility in conceptual combination: Reply to Gagné and Spalding (2006). *Journal of Experimental Psychology: Learning, Memory, and Cognition* 32.1438-42.

NORMAN, DON. 2013. *The design of everyday things*. New York: Basic Books.

R CORE TEAM. 2016. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing.

ROSCH, ELEANOR. 1975. Cognitive representations of semantic categories. *Journal of Experimental Psychology*. 104.192-233.

RUMELHART, DAVID. 1980. Schemata: The building blocks of cognition. *Theoretical issues in reading comprehension*, ed. by R.J. Spiro, B.C. Bruce, & W.F. Brewer, 33-58. Hillsdale, NJ: Lawrence Erlbaum.

RYDER, MARY ELLEN. 1994. *Ordered chaos: The interpretation of English noun-noun compounds*. Berkeley: University of California Press.

SCHANK, ROGER C., AND ROBERT P. ABELSON. 1977. *Scripts, plans, goals, and understanding.* Hillsdale, N.J.: Lawrence Erlbaum Associates Publishers.

SHOBEN, EDWARD J., AND CHRISTINA L. GAGNÉ. 1997. Thematic relations and the creation of combined concepts. *Creative thought: An investigation of conceptual structures and processes*, ed. by T. B. Ward, S. M. Smith, and J. Vaid, 31-50. Washington, DC: American Psychological Association.

SPALDING, THOMAS L., AND CHRISTINA L. GAGNÉ. 2007. Semantic property activation during the interpretation of combined concepts. *The Mental Lexicon* 2.25-47.

SPALDING, THOMAS L., AND CHRISTINA L. GAGNÉ. 2011. Relation priming in established compounds: facilitation? *Memory & Cognition* 39.1472-86.

SPALDING, THOMAS L., CHRISTINA L. GAGNÉ, ALLISON C. MULLALY, AND HONGBO JI. 2010. Relation-based interpretations of noun-noun phrases: a new theoretical approach. *Linguistische Berichte Sonderheft* 17.283-315.

STANFIELD, ROBERT A., AND ROLF A. ZWAAN. 2001. The effect of implied orientation derived from verbal context on picture recognition. *Psychological Science* 12.153-6.

STAUB, ADRIAN, KEITH RAYNER, AND ALEXANDER POLLASTEK. 2007. The time course of plausibility effects on eye movements in reading: Evidence from noun-noun compounds. *Journal of Experimental Psychology* 33.1162-9.

THOMAS, ERIK K. 2011. *Sociophonetics: An introduction*. Basingstoke, UK: Palgrave Macmillan.

TOMASELLO, MICHAEL. 2008. *Origins of human communication*. Cambridge, MA: MIT Press.

TURNER, MARK. 1991. *Reading minds*. Princeton: Princeton University Press.

VAN DIJK, TEUN A. 2008. *Discourse and context: A sociocognitive approach*. Cambridge: Cambridge University Press.

VOLOSINOV, VALENTIN N. 1973. *Marxism and the philosophy of language*. New York: Seminar Press.

WARREN, BEATRICE. 1978. *Semantic patterns of noun-noun compounds. (Gothenburg studies in English, 41.)* Lund: Acta Universitatis Gothoburgensis.

WILSON, NICOLE L., AND RAYMOND W. GIBBS. 2007. Real and imagined body movement primes metaphor comprehension. *Cognitive Science* 31.721-31.

WISNIEWSKI, EDWARD J. 1996. Construal and similarity in conceptual combination. *Journal of Memory and Language* 35.434-53.

WISNIEWSKI, EDWARD J. 1997. When concepts combine. *Psychonomic Bulletin & Review*.

4.167-83.

WISNIEWSKI, EDWARD J., AND DEDRE GENTNER. 1991. On the combinatorial semantics of noun pairs: Minor and major adjustments to meaning. *Understanding word and sentence*, ed. by G.B. Simpson, 241-84. Amsterdam: Elsevier Science.

WISNIEWSKI, EDWARD J., AND BRADLEY C. LOVE. 1998. Relations versus properties in conceptual combination. *Journal of Memory and Language* 38.177-202.

WISNIEWSKI, EDWARD J., AND GREGORY L. MURPHY. 2005. Frequency of relation type as a determinant of conceptual combination: A reanalysis. *Journal of Experimental Psychology* 31.169-74.

WITTGENSTEIN, LUDWIG. 1953. *Philosophical Investigations*, ed. by G.E.M. Anscombe and R. Rhees. Oxford: Blackwell Publishing.

ZWAAN, ROLF A. 1999. Embodied cognition, perceptual symbols, and situation models. *Discourse Processes* 28.81-8.

ZWAAN, ROLF A., AND GABRIEL A. RADVANSKY. 1998. Situation models in language comprehension and memory. *Psychological Bulletin* 123.162-85.