UC San Diego

UC San Diego Electronic Theses and Dissertations

Title

The nature of the semantic scale : evidence from sign language research

Permalink

<https://escholarship.org/uc/item/4hc3k8nj>

Author

Zaremba, Kathryn Davidson

Publication Date

2011

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA, SAN DIEGO

The Nature of the Semantic Scale: Evidence from Sign Language Research

A dissertation submitted in partial satisfaction of the
requirements for the degree
Doctor of Philosophy

in

Linguistics

by

Kathryn Davidson Zaremba

Committee in charge:

Professor Ivano Caponigro, Co-Chair
Professor Rachel Mayberry, Co-Chair
Professor David Barner
Professor Grant Goodall
Professor Robert Kluender
Professor Carol Padden

2011

The Dissertation of Kathryn Davidson Zaremba is approved, and it is
acceptable in quality and form for publication on microfilm and
electronically:

Co-Chair

Co-Chair

University of California, San Diego

2011

TABLE OF CONTENTS

Signature Page	iii
Table of Contents	iv
List of Figures	vi
List of Tables	viii
Acknowledgements	ix
Vita	xii
Abstract	xiii
Chapter 1: Introduction	1
1.1 Scalar Implicatures	5
1.2 The Nature of a Scale	11
1.3 Why ASL	18
Chapter 2: Scalar Implicatures in a Signed Language	29
Chapter 3: Coordination in ASL: a Study of the Role of Lexical Contrast in Scalar Implicatures	64
3.1 Forms of Disjunction in ASL	69
3.1.1 General Use Coordinators	70
3.1.2. Uniquely Disjunction: Fingerspelling and a Historical Sign	80
3.1.3. Not Disjunction, But a Related Discourse Particle	85
3.1.4. Contextual Effects on the Interpretation of ASL Disjunction ...	88
3.2 Quantitative Investigation of an General Use Coordination Scale.....	92
3.3 Discussion and Conclusion	104

Chapter 4: Age of Language Acquisition Effects on Scalar Implicature	
Calculation	115
Chapter 5: Conclusion	156
5.1 Pragmatics in a Sign Language	157
5.2 Including Lexical Contrast in a Theory of Scalar Implicature	160
5.3 The Acquisition of Lexical Contrast	166
5.4 Final Thoughts	169

LIST OF FIGURES

Figure 2.1: SOME and ALL used in the Quantifier sentence type	36
Figure 2.2: TWO and THREE used in the Number sentence type	37
Figure 2.3: Two item and three item trials used in the Ad hoc sentence type.....	41
Figure 2.4: Screenshot during an ASL Number experimental trial	44
Figure 2.5: Design of 36 experimental trials, shown in English	46
Figure 2.6: Accuracy (rejection rates) on the Test trial types for each sentence type in English and in ASL	50
Figure 3.1: COORD-L	71
Figure 3.2: COORD-shift	75
Figure 3.3: #OR	80
Figure 3.4: OR-Which.....	82
Figure 3.5: EITHER	85
Figure 3.6: Screenshot during an ASL quantifier experimental trial.....	95
Figure 3.7: SOME and ALL used in the Quantifier sentence type	96
Figure 3.8: COORD-shift(and) and COORD-shift(or) used in the Coordination sentence type	98
Figure 3.9: Design of 24 experimental trials, shown in English	100
Figure 3.10: Calculation of implicatures (rejection rates) on quantifier and coordinator scales in ASL and English.....	103
Figure 4.1: SOME and ALL used in the Quantifier sentence type	123
Figure 4.2: 3 item and 2 item trials used in the Spatial sentence type	126

Figure 4.3: COORD-shift(and) and COORD-shift(or) used in the Coordination sentence type	128
Figure 4.4: The Relative Clause sentence type	129
Figure 4.5: Participants' ages of ASL acquisition compared to age at testing	131
Figure 4.6: Screenshot during an ASL Quantifier experimental trial	133
Figure 4.7: Scheme showing each sentence type (in English when possible) and trial type	137
Figure 4.8: Native and Nonnative signers' rejection of underinformative sentences.	140
Figure 4.9: Early and Late learners of ASL, rejection of underinformative sentences	142

LIST OF TABLES

Table 2.1: Mean rejection rates for each sentence type in English and in ASL	47
Table 3.1: The use of five disjunction expressions in ASL in alternative questions, exclusive statements, and inclusive statements	88
Table 3.2: Mean rejection rates (with standard deviations) for Quantifiers and Coordination in English and in ASL	101
Table 4.1: Number of participants and average age at testing, average age of ASL acquisition, and average years of ASL experience of each group of participants	132
Table 4.2: Mean rejection rates (with standard deviations) by Native and Nonnative signers for each sentence type	139
Table 4.3: Mean rejection rates (with standard deviations) by Early and Late ASL Learning signers for each sentence type.....	141

ACKNOWLEDGEMENTS

I have been fortunate throughout my time in graduate school at UCSD and while working on this project to have had excellent advisors who knew when to generously give their time and advice and when to wisely let me work through a mess on my own. Ivano Caponigro has encouraged and inspired me in nearly every one of my academic pursuits since I arrived at UCSD, from research, to teaching, to getting involved in the wider linguistics community outside of San Diego. I so very much appreciate his always open door, meticulous notes, patience, and willingness to supervise a project so different from what either of us had done before. Rachel Mayberry has been unwavering in her support of my plans to work on sign language semantics/pragmatics, even though the field barely existed when I started. I am extremely grateful for her years of teachings and guidance about ASL and Deaf culture, experimental design, tracking down obscure references, and for so warmly welcoming me as a part of her lab.

It has been an immense honor to learn about and become involved in a small part in the Deaf community here in San Diego. This project would not have been completed without Marla Hatrak, who provided the signing for the videos in Chapter 3 and 4 and judgments in Chapter 3. I can't thank her and the rest of her family enough for welcoming me, literally, into their home. Brandon Scates was an incredible help in brainstorming ideas and in signing the videos for the experiment presented in Chapter 2. I also owe a huge THANK-YOU to all of my ASL teachers, both at UCSD and in ASL coffee nights throughout the San Diego area.

Among the network of academics that I have been privileged to be a part of in graduate school, I am particularly grateful to David Barner for making me feel at home in

his lab in the last three years and for so many wide-ranging discussions about numbers and scales that influenced this project, to Cami Miner and Corinne Brion for being such enthusiastic research assistants, and to Carol Padden, Robert Kluender, Grant Goodall, Peggy Lott, Gennaro Chierchia, Jonathan Cohen, Amy Lieberman, Gwen Gillingham, Dan Michel, Ryan Lopic, Hope Morgan, Matt Hall, UCSD Semantics Babble, the Mayberry Laboratory for Multimodal Language Development, San Diego Sign Language Research Group, and Maria Polinsky's Language Sciences lab at Harvard for help and suggestions that have made this work much stronger than it would have been otherwise.

On a personal note, this experience would have been a lot more bewildering, a lot less exciting, and probably a lot less caffeinated from trips to the coffee cart without all my fellow graduate students and friends at UCSD, especially Naja Ferjan Ramirez and my cohort-mates Bożena Pająk, who made it all seem reasonable, and Gabe Doyle, who made it all seem fun. I couldn't have imagined a better group of people to have spent this time with. I'm also glad to finally have this opportunity to thank my family, whose love, support, and belief in the value of higher education have brought me where I am today: Andrea (Mom), John (Dad), Laura, and Johnny Davidson, and my grandparents Joe and Rita Nowak and Thelma Davidson, I appreciated every single phone call, electronic and snail mail, and visit to California. And finally, thanks to my husband Jeff Zaremba, who directly contributed to this project as the English speaker in Chapters 2 and 3, and who has allowed "scalar implicature" to become a household phrase. To him, I owe my continued stay on this rollercoaster and the fact that I've made it to the end still believing that the joy of scientific discovery makes the journey worthwhile.

This work was supported by NIH grant T32-DC000041 to the Center for Research in Language at the University of California, San Diego and a Research Grant from the Department of Linguistics at the University of California, San Diego, both awarded to the dissertation author, and a Hellman Faculty Fellows Award and Academic Senate Research Award, both awarded to Ivano Caponigro. Chapter 2 and 3, in full, are currently being prepared for submission for publication of all of the material presented here. [Davidson, Kathryn]. The dissertation author was the primary investigator and author of this material. Chapter 4, in full, is currently being prepared for submission for publication of all of the material presented here. [Davidson, Kathryn; Mayberry, Rachel]. The dissertation author was the primary investigator and author of this material.

VITA

2005	B.A., Mathematics and Linguistics University of Pennsylvania
2005-2006	Teaching Assistant, Department of Philosophy University of Pennsylvania
2006	Research Assistant, Department of Linguistics University of Pennsylvania
2006-2011	Teaching Assistant, Department of Linguistics University of California, San Diego
2009	Visiting Student, Department of Linguistics Harvard University
2010	M.A., Linguistics University of California, San Diego
2011	Summer Graduate Teaching Fellow, Department of Linguistics University of California, San Diego
2011	Ph.D., Linguistics University of California, San Diego

ABSTRACT OF THE DISSERTATION

The Nature of the Semantic Scale: Evidence from Sign Language Research

by

Kathryn Davidson Zaremba

Doctor of Philosophy in Linguistics

University of California, San Diego, 2011

Professor Ivano Caponigro, Co-Chair

Professor Rachel Mayberry, Co-Chair

A difficult learning problem for both children and artificial language learning systems is knowing what is intended to be conveyed based on what is literally said. For example, adults usually take "Some teas contain caffeine" to also convey that "Not all teas contain caffeine", an inference known as a scalar implicature. The present work investigates the role of language-specific knowledge in such inferences through three studies on scalar implicatures in American Sign Language (ASL). The first study

illustrates a new experimental paradigm and compares prototypical scalar implicatures in ASL and English. The second study includes the first investigation of general use coordinators in ASL that can be interpreted as either conjunction ("and") or disjunction ("or"). This provides a test case for the role of language-specific lexical contrast in scalar implicatures, with results showing that lexically non-contrastive scales (i.e., lexical scales whose items differ in meaning but not in form) trigger less scalar implicatures than prototypical lexically contrastive scales, which are based on contrasting lexical items. In the third study, both lexically contrastive and non-contrastive scales are interpreted by deaf native signers and also deaf signers who learned ASL at later ages. Results show that later ASL learners calculated less implicatures than early learning signers, but only on the lexically contrastive scale. Together, these studies support a view that despite their context dependence, scalar implicatures are most likely to be triggered by lexical items which contrast with each other in form to create a context-independent "scale", and that there may even be advantages to learning scales early in life. The dissertation concludes with suggestions for incorporating lexical contrast into theories of implicature and for further study of the semantic/pragmatic interface in sign languages.

CHAPTER 1

Introduction

When we use language to communicate, we are remarkably good at inferring what someone intends to convey, even when it is much more than what they explicitly say. For example, if a writer includes in a review of a restaurant the statement that "It's not the worst restaurant in New York City" this would typically be taken as a negative assessment of the restaurant, despite this being logically a positive thing to say. The reader of such a statement understands that every restaurant except for one in the entire city of New York is not actually the very worst. So instead they take this statement as a negative review, thinking something like "The reviewer and I both know that it's very unlikely that this restaurant is the worst restaurant in the entire city, and so by even bringing up that possibility, she is actually telling me that it is not good at all." This sophisticated piece of reasoning is an additional inference that the reader adds to what most people would agree is the basic, logical, literal meaning (the *semantics*) of the statement "It's not the worst restaurant in New York City." The complex set of rules and reasoning which allow us to know what a speaker meant to say based on the meaning of what she actually said and the context in which she said it are referred to as *pragmatics*. Humans are extremely sophisticated pragmatic users, making use of this ability everywhere from the dinner table to a storefront to a classroom; pragmatic reasoning is one area in which computers attempting to process natural language lag far behind their human counterparts. Consequently, the challenge of understanding more about this aspect of human cognition is an important one in the current field of linguistics.

The philosopher Paul Grice (1967; 1989) made major contributions to the study of pragmatics when he proposed a set of working assumptions ("maxims" of conversation) that participants in a conversation are generally expected to follow. They include the assumptions that people generally try to "Be truthful", to "Make the contribution as informative, but not more informative, than is required", to "Be relevant", and to "Be clear, avoiding obscurity, ambiguity, prolixity, and disorderliness." These generalizations weren't meant as prescriptive rules telling people how to behave, but as descriptive rules that acknowledge the common ways that people typically *do* behave that can explain why many expressions have the intended meaning that they do. In the case of the statement "It's not the worst restaurant in the city", the understanding that people usually try to "Make the contribution informative" suggests to the reader the possibility that the restaurant really is the worst in the city, and so the entire statement is taken as negative review.

One feature of this approach to explaining meaning is that the maxims of conversation are general principles of human reasoning and behavior, and so they should apply in principle to any language. Consequently, it seems that many linguists who study pragmatics have taken the general nature of these rules as a license to focus on a very narrow range of languages, mostly languages spoken in Europe, and occasionally in east Asia (e.g. Davis 1991; Horn & Ward 2005; but see Matthewson 2008), concluding unlike syntax, phonology, or semantics, that such rules are somehow less in need of cross-linguistic study. However, while pragmatic rules themselves may apply generally across languages, they are also directly related to semantic and syntactic rules, which we know vary from language to language. Because of the possibilities of these interactions, the

pragmatic/semantics interface is in great need of cross-linguistic comparison. The present dissertation is a particularly significant departure from the traditional languages studied in pragmatics because it focuses on American Sign Language, which is not only a new language to be studied by pragmatics, but an entirely new modality of communication: signed languages¹.

American Sign Language, or ASL, is the primary language of the Deaf and Hard-of-hearing communities in the United States and much of Canada. The history of the language is nearly as old as the United States itself, beginning with the establishment of a school for deaf students in Connecticut in 1817 by Thomas Hopkins Gallaudet and Laurent Clerc, a French deaf student who had learned French sign language (*langue des signes française*, or LSF) at a school for deaf students in Paris (Van Cleve & Crouch 1989). The language that developed in the American School was consequently influenced by French sign language as well as the students' own gesturing systems with their families and already existing local sign languages used in populations with high incidence of genetic deafness, such as Martha's Vineyard (Van Cleve & Crouch 1989). Although ASL has evolved over generations, it still shows many similarities with French sign language but not, for example, to British Sign Language or many other of the hundreds of various unrelated sign languages in deaf communities throughout the world (Klima & Bellugi 1979).

Structurally, words in ASL are articulated with the hands, and suprasegmental information (such as prosody or intonation) is articulated with movements of the face and

¹ Although the terms "sign languages" and "signed languages" are often used interchangeably, I use the former as a category of natural languages, and the latter when emphasizing the modality of communication, i.e. the fact that they are signed.

body called "nonmanual marking". Words from spoken languages can be borrowed into ASL using the fingerspelling system, and as in any language, new signs are constantly being created as technology and culture continue to develop. Over forty years of linguistics research have shown that sign languages can be analyzed using the same structural tools as spoken languages at the phonological (Stokoe 1960; Sandler 1989), morphological (Klima & Bellugi 1979; Padden 1988), syntactic (Lillo-Martin 1991; Lillo-Martin & Petronio 1997; Neidle 2000), and recently even semantic levels (Caponigro & Davidson 2011; Schlenker 2011). One major contribution of this dissertation then is to show that an important component of sign language pragmatics (i.e. scalar implicature) has a similar structure and can be analyzed using similar tools as spoken language pragmatics.

A second and equally important goal of the current work is to discover if and where sign languages differ in semantic/pragmatic properties from spoken languages, and to use the unique aspects of ASL to learn more about the nature of the relationship of semantics and pragmatics in general. For example, sign languages are perceived through the visual system, and so signs that refer to things that we can perceive visually sometimes have a closer relationship between their physical form and the visual properties of the things to which they refer, e.g. the sign for "bowl" involves a cupping of the hands in the shape of a bowl. One question that can be asked about pragmatics by studying sign languages is whether the sometimes increased transparency in the mapping between meaning and form causes pragmatic interpretations to stray less from the literal semantic interpretation. Secondly, because sign languages use multiple articulators (instead of a single mouth), they more frequently make use of concurrent strategies for

conveying information instead of spoken languages' bias towards strictly linear information flow (Cecchetto et al. 2006; Sandler and Lillo-Martin 2006). Sign languages then allow us to ask how this concurrent nature affects the syntactic/semantic structure and consequently the way that pragmatic meaning is conveyed by, for example, logical connectives. Finally, the linguistic development of many deaf signers follows an unusual path: because most deaf people are born into hearing families who don't know a sign language, they don't receive their first language input from birth as nearly all hearing children do. When input is especially delayed past elementary school age, these signers may have linguistic deficits that persist throughout adulthood (Mayberry 2010). These otherwise cognitively normal adults can help dissociate what aspects of pragmatic reasoning are specific to linguistic development or to cognitive maturity, which is impossible in typically developing hearing children who often show deviations from adult pragmatic behavior but are still developing both cognitively and linguistically.

1.1 Scalar Implicatures

In this dissertation I focus on one especially vexing problem in pragmatic understanding: how two participants in a conversation settle on what amount of information is meant to be conveyed in a given statement. Probably the most well-studied example of this type of reasoning is a *scalar implicature*, the name given to the inference in (1b) that a listener makes when a speaker says (1a).

- (1) a. Some teas contain caffeine.
- b. Not all teas contain caffeine.

For many people, inferring (1b) from (1a) seems like an obvious conclusion, because if *all teas* contained caffeine, then the speaker would have said "all teas" instead of "some teas", because "some" and "all" mean different things. But consider (2a-c), where here, "some teas" is actually meant to include "all teas" as well (this can be seen from the paraphrases given in parentheses).

- (2) a. If some teas contain caffeine, Bob won't drink tea.

(Bob won't drink tea if **some**, and certainly if **all**, teas contain caffeine.)

- b. Everyone who drank some teas containing caffeine will be awake.

(You'll be awake if you drank **some** teas containing caffeine, and also if you drank **all** teas containing caffeine.)

- c. No one who drinks some tea containing caffeine will fall asleep.

(No one who drinks **some**, or **all**, teas containing caffeine will fall asleep.)

How then do participants in a conversation know when "some" should mean *some and not all* as in (1), and when it means *some and maybe all* as in (2)? We might want to say that "some" is ambiguous between the two meanings: the speaker meant "some" in one sense in (1), and in another sense in (2), just as "bat" can in different contexts refer to a flying mammal or to a piece of baseball equipment. One might posit this analysis of "some" if the pattern in (1) were an isolated incident, but it becomes a much less

appealing analysis when we find that the same pattern of contexts where "some" excludes or includes "all" isn't limited to the pair <all, some>, which are both in the semantic category of *quantifiers*, but also holds for a wide variety of semantic categories such as logical connectives <and, or> (3), modals <must, may> (4), numbers <..., three, two, one> (5), and adjectives <hot, warm> (6), just to name a few.

- (3) a. The child drank green or black tea.

(The child drank green **or** black tea, but **not** green **and** black tea.)

- b. If you drank a green or a black tea, you'll see how delicious they are.

(You'll see how delicious they are if you drink a green tea **or** a black tea, and also if you drink a green tea **and** a black tea.)

- (4) a. You may drink a black tea.

(You **may** drink a black tea, but it's **not** the case that you **must**.)

- b. If you may drink a black tea, I would like to have one too.

(Let me have one if you **may**, or if you **must**, drink one.)

- (5) a. She drank two cups of tea.

(She drank **two**, but **not three**, cups of tea.)

- b. If you drink two cups of tea, you'll get sick.

(You'll get sick if you drink **two**, or **three** (or more) cups of tea.)

- (6) a. The tea is warm.

(The tea is **warm** but **not hot**.)

- b. If the tea is warm, the ice will melt in it.

(If the tea is **warm**, and especially if it is **hot**, the ice will melt in it.)

For each example above, the plain declaratives similar to (1) and the conditional similar to (2a) are shown, while the relative clause structures similar to (2b) or negations similar to (2c) have been omitted for easier reading. However, for the relative clause and negation, the pattern is exactly the same: just as in (3)-(6)b, the weaker term is intended to include the stronger term, in contrast to (3)-(6)a, where it does not. Although each example on its own seems like it could be an instance of ambiguity, taken together they all point towards a more general phenomenon.

The theory of scalar implicature suggested by Grice (1967; 1989) based on his maxims of conversation and further developed by Horn (1989) is a way of accounting for the two meanings of such terms without positing ambiguity. According to this theory, the basic meaning of the weaker terms like "some" (and similarly for "may", "or", "warm", etc.) is the meaning in (2), equivalent to "some and maybe all." Then in situations like (1) the meaning gets enriched to mean "some and not all" because the speaker and hearer reason as follows:

- (i) The speaker said "Some teas contain caffeine", which is equivalent in meaning to "Some and maybe all teas contain caffeine."

- (ii) If all teas contained caffeine, the speaker could have just as easily said "All teas contain caffeine," which if true would be more informative.
- (iii) One of the Maxims of conversation that people follow is to "Make your contribution as informative, but not more informative, than is required."
- (iv) Since the speaker didn't use the stronger term "all", they must have had a reason not to use it.
- (iv) Another Maxim says only to say what you believe to be true.
- (v) The reason the speaker didn't use "all" is probably because the speaker thought the stronger term is false, and was trying to maintain truth.
- (vi) Conclude (1b) "Not all teas contain caffeine."

The reason that the process in steps (i)-(vi) doesn't go through for the "inclusive" examples like (2) and (3)-(6)b is that the enriched meaning would actually *weaken* the statement: step (ii) no longer holds because saying "Some and not all" in the context of conditionals, relative clauses, or negation is not a more informative thing to say and so the implicature is thus not drawn. A large body of recent research on the topic of scalar implicatures revolves around the more detailed differences between the (a) and (b) sentences. The traditional view that scalar implicatures are based on (mostly subconscious) reasoning like that presented in steps (i)-(vi) is still supported today (van Rooij & Schulz 2004; Russell 2006), but recently others have suggested that scalar implicatures can be in a sense "automatic" and always part of the meaning without going through all of the steps (i)-(iv), and then are canceled in contexts like the (b) sentences (Levinson 2000); yet others suggest that the generation of the "implicatures" in the (a)

sentences are the product of a grammatical process conditioned on the semantic properties of the environments, and less about reasoning about speakers' intentions (Chierchia 2006; Fox 2006; Chierchia et al. to appear).

Crucially, the overall idea that a scalar implicature accounts for the difference in meaning between "some" as *some and not all* and as *some and maybe all* (versus having two meanings, as in homophones like "bat") is shared by all of these theories. It is also further supported by examples like (7) showing that the extra pragmatic meaning that we get via scalar implicature is, in fact, extra because it can be canceled (and thus the stronger meaning is not a completely separate meaning). Compare (7a), which is initially interpreted as the strong meaning but is clarified to be the weak meaning, with the absurd (notated with #) sentence in (7b), which shows a failed attempt to "clarify" to a completely separate meaning, *none*.

- (7) a. Some teas contain caffeine - in fact, all do!
 b. #Some teas contain caffeine- in fact, none do!

Furthermore, the hypothesis of scalar implicatures to account for the strong meaning of words like "some" is supported by psycholinguistic experiments. Participants take longer to respond in behavioral experiments when they need to calculate scalar implicatures than where they don't (Bott & Noveck 2004; Storto & Tanenhaus 2005) and they also have more difficulty calculating scalar implicatures when their overall processing load is increased (De Neys & Schaeken 2007). Preschool and early elementary school children, who are otherwise quite fluent in their language, show strikingly less scalar implicature

calculation than adults (Noveck 2001; Chierchia et al. 2001; Papafragou & Musolino 2003; Huang & Snedeker 2009, among others). Children's behavior is especially indicative of a separation of semantic meaning and additional pragmatic meaning because children have only had input that is based on adults' use of the terms, which does involve scalar implicatures, and yet children initially don't interpret scalar terms with implicatures.

1.2 The nature of a scale

Given the evidence that speakers have a systematic way to transfer between the "weak" and the "strong" meaning of many terms in the language and still be clearly understood by their interlocutors (via scalar implicature), one major area of investigation in semantics and pragmatics has been to determine why and how this reasoning occurs with such regularity (for overviews, see Levinson 2000; Breheny et al. 2006; Chierchia et al. to appear; Guertz 2009; Sauerland 2011). Horn (1989) originally suggested that the regularity of scalar implicatures can be attributed to a special relationship between each pair of weak and strong words (e.g. <all, some>) called a "scale", which quickly allows the listener to consider the appropriate alternative statement in step (ii) above. As mentioned, most theories of scalar implicature differ on how exactly the implicatures are drawn (e.g. steps (i)-(vi)), and in particular the differences between the contexts where they are and are not drawn, but the one similarity they all share is the idea that the inferences are based on a scale. Surprisingly there has been very little established in previous research about what exactly is a scale as a linguistic object (e.g. to what level of linguistic representation it belongs, among other things), and whether it is a relationship

which holds by necessity because of the semantics, or because of conventionalized memorized lexical information. This question is the semantic/pragmatic focus of this dissertation.

One of the initial requirements proposed for scales since Horn (1989) is that one of the terms (e.g. "all") should be strictly stronger than the other, weak term (e.g. "some"). This has been defined technically using the semantic notion of entailment: a sentence A entails another sentence B if in every situation where A is true, B is also true. Regarding scales, for any strong and weak scale items $\langle s, w \rangle$, and a sentence frame $S(x)$, it should be the case that $S(s)$ entails $S(w)$. The example in (8) illustrates this with the scalar implicature shown in (1).

- (8) a. $S(x) = x$ teas contain caffeine; $\langle s, w \rangle = \langle \text{all}, \text{some} \rangle$
 b. $S(s) = \text{All teas contain caffeine}$
 c. $S(w) = \text{Some teas contain caffeine}$
 d. $S(s)$ entails $S(w)$ because in every situation in which $S(s)$ is true, $S(w)$ is true;
 $\langle s, w \rangle$ can form a scale

The same entailment requirement holds for other scalar terms: $S(s) = \text{"The child drank green and black tea."}$ entails $S(w) = \text{"The child drank green or black tea"}$, thus $\langle \text{and}, \text{or} \rangle$ forms a scale, and so on. Note that this requirement is purely a semantic one, and says nothing about the form of s and w . This is not accidental: Grice intended implicatures to be non-detachable, such that two different forms with a similar meaning are expected to

trigger the same implicatures. For example, the quantifiers "some" and "a few" have similar meanings, and generate similar implicatures as seen in (9)(Grice 1967;1989).

- (9) a. Some teas contain caffeine.
 (Not all teas contain caffeine.)
 b. A few teas contain caffeine.
 (Not all teas contain caffeine.)

So, there is strong evidence for a semantic component of scales: two possible scalemates which are in a certain semantic relationship can form a scales based on their meanings.

However, some conditions on form of a scale must be made, because there are examples in which two possible scalar terms fulfill the entailment requirement, but fail to trigger a scalar implicature. Consider the quantifier "only some", which is strictly stronger than "some" (10), and yet (11b) is not implicated when sentence (11a) is uttered (Horn 2000; Katzir 2007).

- (10) a. $S(x) = x$ teas contain caffeine; $\langle s, w \rangle = \langle \text{only some, some} \rangle$
 b. $S(s) = \text{Only some teas contain caffeine}$
 c. $S(w) = \text{Some teas contain caffeine}$
 d. $S(s)$ entails $S(w)$ because in every situation in which $S(s)$ is true, $S(w)$ is true;
 $\langle s, w \rangle$ should be able to form a scale

(11) a. Some teas contain caffeine.

does not implicate--->

b. Not only some teas contain caffeine.

The difference between <all, some> and <only some, some> as proposed scales, then, has been suggested to be one of relative complexity: "only some" is more complex than "some", while "all" is not, and so step (ii) above does not go through because the alternative "Only some teas contain caffeine" is not just as easy to say as "Some teas contain caffeine." But how can we measure linguistic complexity? Matsumoto (1995) suggests adding a requirement on the form of a scale such that any two scalemates should not differ in the amount of morpho-phonological segments they contain. Since "only some" is more complex than "some" or than "all", it is not considered a possible scalemate, which is why there is no scalar implicature in (11b). Taking a more syntactic approach, Katzir (2007) suggested that the alternative statements S(s) and S(w) should be such that S(s) is no more syntactically complex than S(w) (i.e. the syntactic structure of S(s) is the same as S(w) or can be arrived at by deleting parts of the syntactic structure of S(w)). So although it's unclear exactly how the concept of complexity should be cashed out, there seem to be some structural requirements on complexity in addition to the semantic requirements of entailment.

Both the entailment requirement on scales and the complexity requirement on scales are motivated by Grice's maxims: "Be informative: don't say more or less than is required" explains why the implicature rules out strictly stronger terms, while the maxim to "Be brief" explains why a stronger but more linguistically complex term would not be

ruled out in an implicature. So, we can conclude that two items X and Y will trigger a scalar implicature if they have a certain semantic relationship illustrated above, where a sentence frame with only the words exchanged results in one sentence strictly entailing the other, and furthermore, that the stronger term is not more lexically complex than the weak term, and all of this can be gotten by following Grice's maxims.

However, there is an alternative proposal for the nature of a scale in which the relationship between the scalar items is conventionalized and even memorized as part of its lexical information, along the lines suggested by Levinson (2000). Under a lexical/"conventionalized" theory of scales, part of the reason that the scale emerges is because of the lexical contrast between the scalar items: "only some" is different in form, but is not a different lexical item than "some"; therefore, they fail to form a semantic scale. This contrasts with "some" and "all", which are clearly different lexical items, and thus can contrast with each other for the purpose of implicature, and because they have the semantic relationship of entailment, they can result in scalar implicatures. The difference between the traditional purely semantic theory and the conventionalized theory of scales can be thought of as follows: the semantic theory of scales says that a scale exists by necessity whenever two terms are in an entailment relationship and the stronger term is no more linguistically complex than the weaker term. Scales do not need to be learned, they just exist by virtue of their meanings. The conventionalized theory of scales says that a scale is a conventionalized entity, made up of two terms which speakers have learned belong in contrast to each other: the fact that their meanings are what they are is not sufficient to make them a scale.

Some evidence for the conventionalized theory of scales comes from so-called on "ad hoc" scales (Katsos 2009)(12).

(12) Zoltan drank tea, coke, and water.

(Zoltan didn't drink coffee, or anything else for that matter.)

In these cases, like with the scalar implicatures shown above, there is an implicature that nothing stronger could be said in (12), as shown in parentheses. Also like scalar implicatures, participants in the conversation both generally arrive successfully at the right quantity of information to be conveyed, but unlike scalar implicatures the alternative statements under consideration never hinge on the meaning of a single word, but instead it's the overall meaning of the sentence. The mere existence of such implicatures supports a semantic theory, but further investigation by psycholinguistic experiments on these scales actually favors the conventionalized theory because young children are typically very good at these types of implicatures (Katsos 2009; Barner et al. 2010; Stiller et al. 2011), in contrast to scalar implicatures. If scalar implicatures involve nothing more than a comparison of alternative propositions like those in (12), it's unclear why children behave differently on ad hoc scales than prototypical Horn scales like those seen above. On the other hand, under the conventionalized theory, in which there is a component of lexical contrast to Horn scales that must be memorized, it's possible to explain why children, who haven't learned the scales yet, have difficulty with scalar implicatures. Furthermore, it would predict that adults interpret more implicatures based

on Horns scales, which have the conventionalized component, than on ad hoc scales, where interpretations would be more flexible.

These accounts make different predictions regarding the behavior of a scale having the semantics of a typical Horn scale but lacking lexically contrastive scalemates: under a conventionalized theory, Horn scales should generate more implicature interpretations than scales not based on lexically contrastive scalemates. In the purely semantic theory, there is no distinction between a scale based on a lexical item that is linked to another item, and an inference that arises based on the calculated meaning of the sentence as a whole.

Although the nature of scales is only one small subpart of the debate on how scalar implicatures are calculated, it's not orthogonal to the larger debate because two of the three main competing theories of scalar implicatures explicitly or implicitly use lexical scales: the Lexical theory of implicatures (Levinson 2000) and the Grammatical theory of implicatures (Chierchia 2006; Fox 2006; Chierchia et al. to appear), terminology used by Sauerland (2011). The Lexical theory is explicitly dependent on lexical scales because it assumes that scalar implicatures are the product of pragmatic reasoning but become conventionalized so that the presence of a scalar item is what automatically triggers an implicature. Knowing which words are scalar items (e.g. *some*) and which are not requires a memorized linking between scalar items their scalemates. Like the Lexical theory of scalar implicatures, the Grammatical theory also takes scalar implicatures to be automatic, but instead of triggering an implicature in Grice's original sense, they trigger a grammatical process in the syntax/semantics. Having scales as a memorized relationship between words allows for the automaticity in this theory;

otherwise, the speaker would have to reason about the meanings of the terms when they combine with the rest of the sentence, which is exactly the approach that these theories reject. Automaticity in scalar implicatures has been tentatively supported by experimental evidence based on reading time and eyetracking studies which show scalar implicature calculation occurring before the end of a sentence (Storto & Tanenhaus 2005; Panizza et al. 2009). However, it is still rejected by many researchers for the simple fact that the traditional Gricean account presented in (i)-(vi) requires so little other complex machinery, relying on basic generalizations about conversational behavior and not on any special cognitive or grammatical structures (Russell 2006; Guertz 2009; Sauerland 2011). By addressing specifically the nature of the scale in this dissertation, my goal is to add information to this debate of a different kind: not the time course of the implicature process, but whether the form of the scale, separate from its semantics, affects the frequency of implicature calculation.

1.3 Why ASL

In this paper, I look at American Sign Language to answer the question of what makes up a "scale" based on unique aspects of both the language and its users. One of these unique aspects of the linguistic structure of ASL is that ASL makes use of what I call "general use coordinators". Coordinators connect constituents: two examples in English are "and" (which conveys conjunction) and "or" (which conveys disjunction). In Chapter 3 of this dissertation I show the many ways that ASL conveys disjunction, including two general use coordinators. These coordinators exhibit all of the same syntactic and semantic properties of the coordinators "and" and "or" in English, except

that each coordinator can be interpreted as either conjunction ("and") or disjunction ("or"), depending on the context and additional suprasegmental marking for the disjunctive interpretation. What this means is that in ASL, the coordinators that we can translate into English as "and" and "or" fulfill all of the properties of the semantic account of a scale: a sentence with "and" entails a sentence with "or", and also "and" is not more complex by any reasoning (in fact, if anything it is less complex because "or" has nonmanual marking). However, it doesn't fulfill the requirements for a conventionalized scale: there are no lexical items to stand in contrast to each other. ASL can thus allow us to test how crucial lexical contrast is for scalar implicature calculation.

In the second part of Chapter 3, I present an experiment to test exactly this: the role of lexical contrast in scalar implicatures. Native speakers of English and native signers of ASL were both tested on their calculation of implicatures based on a typical scale (quantifiers <all, some>) in their native language and the coordination scale in their native language (<and, or>, a typical scale in English but a general coordinator scale in ASL). Results show that signers compute less implicatures on the coordinator scale in ASL than the quantifier scale in ASL, and also less on the coordinator scale in ASL than speakers of English compute for the coordinator scale in English. Both results suggest that lexical contrast is an important aspect of scales, that the purely semantic account of scales cannot be correct, and that if scalar implicatures are not grammatical, they seem to be at least conventionalized, as in the Lexical or Grammatical theories.

Another distinction between the semantic account and the conventionalized account of the nature of a scale is that the learning problem is distinctly different in each case. In the case of a semantic scale, the language learner must learn the maxims of

conversation, essentially learning how to conduct an appropriate conversation by deducing what his interlocutors intend to be convey throughout the conversation. In the case of a lexical "conventionalized" scale, the child may also need to learn maxims, but additionally must acquire the knowledge that the contrasting lexical terms form a scale. We know that young children have difficulty with scalar implicatures: four-year-olds interpret "or" in a literal sense, accepting "Bob ate the cookies or the cake" when in fact he ate both, while adults and older children will typically reject that description as false or underinformative, but there is still disagreement about why. Is it because children react differently to pragmatic violations than adults (Katsos & Smith 2010, Katsos & Bishop 2010), because they have decreased processing abilities (Chierchia et al. 2001) or because they have not made the connection between contrasting lexical items in a scale (Barner et al. 2010)? Unfortunately, children are both socially and linguistically more immature than adults, and dissociating these aspects can be difficult.

Studying scalar implicatures in American Sign Language affords us a unique opportunity for the dissociation of language development and cognitive maturity in addressing the question of why children interpret scalar sentences more logically because the great majority of deaf children are born to hearing parents who do not sign (exact numbers are difficult to determine, see Mitchell & Karchmer 2004). These children are unable to acquire in full the language of their caregivers from birth in the way that nearly all hearing children do. In the USA, deaf children of hearing parents may be exposed to ASL at various ages (anytime from before entering school to after attending college), during which time they are also exposed to varying amounts of English. Importantly, neither language can be learned in a typical, native manner for these nonnative signers,

and so despite having otherwise normal cognitive abilities, these children have been shown to have deficits as adults in processing complex linguistic grammatical structures even after 20 or more years of using ASL (Newport 1990; Boudreault & Mayberry 2006; Mayberry 2010).

Chapter 4 of this dissertation compares native signers with signers who learned ASL at various ages between age 2 to 18 on a scalar implicature task to assess whether adult participants who are cognitively normal but may have diminished linguistic abilities are affected in their calculation of scalar implicatures. Results show that for typical Horn scales like quantifiers <all, some>, there is a significant difference: signers who learned ASL early in childhood calculate more implicatures than later learning signers. However, this contrast was not found in two other scales tested that did not involve a lexical contrast: an ad hoc scale, similar to (12), and a general coordinator scale, as discussed above. In each of these cases, there was no required lexical scale to learn, and no difference between native and nonnative signers' performance on scalar implicature calculation. Results from this study raise the intriguing idea that not only are scales based on lexical contrast, but that learning this contrast benefits from exposure to the language in early childhood when language acquisition is most robust.

Both the study in Chapter 3 on coordination in ASL and the study in Chapter 4 on nonnative signers' calculation of implicatures rely on a basic understanding of how scalar implicatures work in ASL. Therefore, Chapter 2 presents a study comparing calculation of scalar implicatures in ASL with scalar implicatures in English to set a baseline for these studies and the general study of pragmatics in ASL. I take two areas in which the visual-manual modality may present unique pragmatic affects: increased transparency of

meaning and the spatial information conveyed through the classifier system. The first was tested by including the signs for numbers *one* through *five* in ASL, in which the number of fingers extended in the sign is equal to the number that the sign represents, and therefore has a clear mapping between form and meaning. We know very little about how transparency affects pragmatic interpretation: is pragmatic meaning restricted to being more literal, or not? Secondly, in ASL signers can make use of the size and location classifier system in a wide variety of sentences, including an ad hoc scale with a spatial layout like in (12). These classifiers include information about the size, shape, and placement of each item, something for which there is no equivalent without using gesture in English and other spoken languages due to the physical properties of each modality of communication. Here, too, we can ask whether this unique property of sign languages has effects on the pragmatics. To investigate each of these potentially unique aspects of ASL, various scales were compared to a baseline within the same group of signers: all signers are tested on these scales and also a prototypical Horn scale in ASL base on quantifiers <all, some>, which do not have any modality specific properties.

Results show that implicatures are for the most part drawn in ASL exactly like they are in English. For the prototypical quantifiers scale, there is no difference between responses by native speakers of English and native signers of ASL on their respective languages, and similar results are also found for the numbers. One marginal difference appears in the ad hoc case, where classifiers were used in ASL. This sets up the experimental paradigm for use in subsequent experiments, and shows that while transparency does not appear so far to affect pragmatic interpretation, there may be additional pragmatic processes involved in classifier constructions.

Because this is the first study of experimental pragmatics in a sign language, it was necessary to devise a new experimental paradigm, and the results both in English and ASL show this paradigm was successful, generating results consistent with previous results on scalar implicatures in spoken languages. The method for gathering quantitative data on pragmatic behavior involved creating an experiment on a laptop, which can be brought to more than one location to enhance recruitment of deaf participants. Using non-linguistic based input (here, smile and frown faces) also removes some of the spoken/written language influence from the computer interface. Finally, using a native signer both to create the stimuli and also, if the experimenter is not a native signer, to join in testing sessions is suggested. Future research using this paradigm could investigate various other semantic/pragmatic phenomena in signed languages, such as presupposition and other types of implicatures.

Overall, the results from these studies of scalar implicatures in ASL provide good evidence even in offline tasks using an understudied language (ASL) and modality (visual-manual) for language-specific knowledge in scalar implicatures. Specifically, results show that the scales which generate the most scalar implicature interpretations are based on contrasting lexical items, such as <all, some>. Scales that do not, such as ad hoc scales, and even a generalized coordinator scale in ASL, trigger less scalar implicature interpretations. Furthermore, such lexical contrast seems to be best learned early in life. This adds a new piece of evidence to increasingly mounting support for a more automatic theory based on conventionalized lexical scales, despite what some consider the inherent attractiveness of the traditional Gricean story (Sauerland 2011). I conclude with some thoughts on how pragmatic theory can incorporate automaticity while still considering

that language is in fact a communicative act, and the best explanations for pragmatic phenomena in both signed or spoken languages should be both consistent with users' behavior and well-motivated.

Because this investigation concerns both sign language research and the semantics/pragmatics interface, researchers in each of these fields form at least two separate audiences for this work. I will therefore try throughout each paper to include background in ASL for those who are unfamiliar with sign languages, and less formal descriptions of each pragmatic phenomena to accompany more formal descriptions. Each paper also has an experimental aspect, which may be familiar to a greater or lesser extent to both of these groups, and I do my best to present these results in a conventional format. In general, each of the three chapters 2-4 which form the core of the dissertation are intended as separate papers on their own, and so each will be presented separately with their own appendices and references immediately following.

References

- Barner, D., Brooks, N., & A. Bale (2010). "Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference." *Cognition* 118(1), 84-93.
- Bott, L. & I. Noveck. (2004). "Some utterances are underinformative: The onset and time course of scalar inferences." *Journal of Memory and Language* 51(3). 437-457.
- Boudreault P. & R. Mayberry (2006). "Grammatical processing in American Sign Language: Age of first-language acquisition effects in relation to syntactic structure." *Language and Cognitive Processes* 21, 608-635.
- Breheny, R., Katsos, N. & J. Williams. (2006). "Are generalised scalar implicatures generated by default? An on-line investigation into the role of context in generating pragmatic inferences." *Cognition* 100(3). 434-463.

- Caponigro, I. & K. Davidson. (2011) "Ask and Tell as Well: Question-Answer Clauses in American Sign Language." *Natural Language Semantics*
- Cecchetto, C., Geraci, C. & S. Zucchi (2006). "Strategies of Relativization in Italian Sign Language." *Natural Language & Linguistic Theory* 24(4). 945-975.
- Chierchia, G. (2006). "Broaden Your Views: Implicatures of Domain Widening and the "Logicality" of Language." *Linguistic Inquiry* 37(4). 535-590.
- Chierchia, G. Fox, D. & B. Spector (to appear) "The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics." in Portner, P, Maienborn, C. & K. von Steubner (eds.), *An International Handbook of Natural Language Meaning*, Mouton de Gruyter.
- Chierchia, G., Crain, S., Guasti, M. T., Gualmini, A., & L. Meroni (2001) "The Acquisition of Disjunction: Evidence for a Grammatical View of Scalar Implicatures," in A. H.-J. Do et al., eds., *BUCLD 25 Proceedings*, Cascadia Press, Somerville, Massachusetts.
- Davis, S. (1991) *Pragmatics. A Reader*. Oxford: Oxford University Press
- De Neys, W. & W. Schaeken. (2007). "When people are more logical under cognitive load." *Experimental Psychology* 54(2). 128-133.
- Fox, D. (2006) "Free choice and the theory of scalar implicatures." in U. Sauerland and P. Stateva (eds.) *Presupposition and Implicature in Compositional Semantics*. Palgrave Macmillan, Basingstoke. U.K. 71-120.
- Grice, H. (1967; revised and published 1989). *Studies in the Way of Words*. Harvard University Press, Cambridge, MA.
- Geurts, B. (2009). "Scalar Implicature and Local Pragmatics." *Mind and Language* 24(1). 51-79
- Horn, L. (1989). *A Natural History of Negation*. University of Chicago Press: Chicago.
- Horn, L. (2000). From IF to IFF: Conditional perfection as pragmatic strengthening. *Journal of Pragmatics*, 32, 289–326
- Horn, L & G. Ward. (2005). *The Handbook of Pragmatics*. Wiley-Blackwell
- Huang, Y. & J. Snedeker (2009). "Online interpretation of scalar quantifiers: Insight into the semantics–pragmatics interface." *Cognitive Psychology* 58(3), 376-415.

- Katsos, N. (2009). "Evaluating under-informative utterances with context-dependent and context-independent scales: experimental and theoretical implications." In Sauerland, U. & Yatsushiro, K., *Experimental Semantics and Pragmatics*. Basingstoke: Palgrave Studies in Pragmatics, Language & Cognition. 51-73.
- Katsos, N. & N. Smith (2010). "Pragmatic tolerance and speaker-comprehender asymmetries." In Franich, K., Iserman, K., & L. Keil (eds.), *Proceedings of the 34th Annual Boston Conference in Language Development*. Cascadilla Press, MA. 221-232.
- Katsos, N. & D. Bishop (2011). "Pragmatic tolerance: Implications for the acquisition of informativeness and implicature." *Cognition* 120(1). 67-81.
- Katzir, R. (2007). "Structurally-defined alternatives." *Linguistics and Philosophy* 30(6). 669-690.
- Klima, E. & U. Bellugi (1979). *The Signs of Language*. Boston: Harvard University Press
- Levinson, S. (2000). *Presumptive Meanings: the Theory of Generalized Conversational Implicature*. MIT Press: Cambridge.
- Lillo-Martin, D. (1991). *Universal grammar and American Sign Language: setting the null argument parameters*. Kluwer: Dordrecht, Netherlands.
- Lillo-Martin, D. & K. Petronio (1997). "Wh-Movement and the Position of Spec-CP: Evidence from American Sign Language" *Language* 73(1). 18-57.
- Matthewson, L. (2008.) "Pronouns, Presuppositions, and Semantic Variation." *Proceedings of SALT XVIII*, 527-550.
- Matsumoto, Y. (1995). "The conversational condition on Horn Scales." *Linguistics and Philosophy* 18(1). 21-60.
- Mayberry, R. (2010). "Early Language Acquisition and Adult Language Ability: What Sign Language reveals about the Critical Period for Language." In M. Marschark & P. Spencer (Eds.), *Oxford Handbook of Deaf Studies, Language, and Education- Volume 2*, 281-291.
- Mitchell R., & M. Karchmer (2004). "Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the United States." *Sign Language Studies* 4(2), 138-163.
- Neidle, C. (2000). *The Syntax of American Sign Language*. MIT Press: Cambridge.

- Newport, E. (1990) Maturational constraints on language learning. *Cognitive Science* 14:11– 28.
- Noveck, I. (2001). "When children are more logical than adults: Experimental investigations of scalar implicature" *Cognition* 78(2), 165-188.
- Padden, C. (1988). *Interaction of morphology and syntax in American Sign Language*. Garland Outstanding Dissertations in Linguistics.
- Panizza, D., Chierchia, G., Huang, Y., & J. Snedeker, (2009). "The relevance of polarity for the online interpretation of scalar terms." Paper presented at *Semantics and Linguistic Theory (SALT) 19*, Columbus, OH, April 2009.
- Papafragou, A. & J. Musolino (2003). "Scalar Implicatures: experiments at the semantics-pragmatics interface." *Cognition* 86(3). 253-282.
- Russell, B. (2006). "Against Grammatical Computation of Scalar Implicatures." *Journal of Semantics* 23. 361-382.
- Sandler, W. (1989). *Phonological Representation of the Sign: Linearity and Nonlinearity in American Sign Language*. Publications in Language Sciences.
- Sandler, W. & D. Lillo-Martin (2006). *Sign Language and Linguistic Universals*. Cambridge: Cambridge University Press.
- Sauerland, U. (2011). "The Computation of Scalar Implicatures: Pragmatic, Lexical or Grammatical?" Unpublished manuscript. <http://semanticsarchive.net/>
- Schlenker, P. (2011). "Quantifiers and Variables: Insights from Sign Language (ASL and LSF)". In Partee, B.H., Glanzberg, M., & Skilters, J. (eds), *Formal Semantics and Pragmatics: Discourse, Context, and Models. The Baltic International Yearbook of Cognition, Logic and Communication, Vol. 6*.
- Stiller, A., Goodman, N., & M. Frank. (2011). "Ad hoc scalar implicature in adults and children." *Proceedings of the 33rd Annual Meeting of the Cognitive Science Society*.
- Stokoe, William C. (1960). "Sign language structure: An outline of the visual communication systems of the American deaf." *Studies in linguistics: Occasional papers (No. 8)*. Buffalo: Dept. of Anthropology and Linguistics, University of Buffalo.
- Storto, G. & M. Tanenhaus (2005). "Are scalar implicatures computed online?" in E. Maeir, Bary, C. & Huitink (eds.) *Proceedings of Sinn und Bedeutung* 9., 431-445. Nijmegen: Nijmegen Centre for Semantics.

Van Cleve, J. & B. Crouch (1989). *A Place of Their Own: Creating the Deaf Community in America*. Gallaudet University Press.

van Rooij, R. & K. Schulz (2004). "Exhaustive interpretation of complex sentences."
Journal of Logic, Language and Information 13, 491–519.

CHAPTER 2

Scalar Implicatures in a Signed Language

Abstract

This paper tests the calculation of scalar implicatures in American Sign Language (ASL) in one of the first studies of experimental pragmatics in the manual/visual modality. Both native signers of ASL and native speakers of English participate in an automated Felicity Judgment Task to compare both traditional lexically-based and "ad hoc" scalar implicatures in their respective languages. Results show that native signers of ASL do calculate scalar implicatures based on the lexical scale <all, some> in ASL to the same extent and in the same pattern of native speakers of English. There are also similarly high scalar implicature/exact interpretations of numbers *one* through *five* in ASL as in English, despite the transparent mapping of form and meaning in numbers ASL. One difference between participants' implicatures drawn in ASL and English was in an ad hoc scale that made use of the unique ability of ASL to convey spatial information using the classifier system. There were more implicatures based on this scale in ASL than for English, in which the sentence was similar except for the lack of spatial information. Interpretations of these results for the further study of pragmatics in signed languages and for the better understanding of the nature of semantic scales are discussed, and the paper concludes with suggestions for further research in sign language semantics/pragmatics.

In the last half-century linguists have successfully applied formal and conceptual tools borrowed from logic, mathematics, and the philosophy of language to the investigation of human languages in order to understand how sentences convey meaning (the domain of semantics) and how meanings can be affected by different contexts (the domain of pragmatics). At the same time, linguists and psychologists have also made progress in the understanding of sign languages by using the concepts and techniques that have been developed for spoken languages. The overwhelming consensus coming from sign language studies is that the structure of sign languages generally follows the same fundamental properties as the structure of spoken languages. However, the interaction of semantics and pragmatics has yet to be investigated in sign languages, with most work related to this area of sign language research happening either only strictly within semantics or at the syntax/semantics interface (e.g. Zucchi 2009; Pfau & Quer 2010; Schlenker 2011). This paper focuses on one of the most well-studied phenomena at the interface of semantics and pragmatics, and uses experimental methods to test whether there is a corresponding phenomenon in American Sign Language, and what it's occurrence in the visual/manual modality can tell us about the nature of semantics and pragmatics for both spoken and sign languages.

The phenomenon at the center of this investigation is the fact that when most people hear (1a), they will also consider (1b) to be true.

- (1) a. Mary ate some of the cookies.
- b. Mary didn't eat all of the cookies.

According to the analysis originating with Grice (1967; 1989) and further developed by Gazdar (1979) and Horn (1989), the basic meaning of (1a) is that Mary ate *at least some* of the cookies. In other words, (1a) is technically true in any situation where she ate at least one cookie: maybe all of the cookies or maybe not all, but at least one. This is a rather weak statement: the only possibility that it rules out is that Mary didn't eat any cookies. As a next step, this basic meaning of (1a) gets pragmatically strengthened by the listener's consideration that if "Mary ate all of the cookies" were true, then the speaker should have said that, since it would have been just as easy to say as (1a) but it would have been a better description of the facts. Since the speaker didn't choose to say that, and participants in a conversation generally give the most informative description that they can easily provide, then it must be false. Hence, the listener concludes (1b). This extra inference (1b) is known as a *scalar implicature*: "scalar" because participants are considering what to say based on a scale of informativity, and an "implicature" because (1b) doesn't follow from (1a) by necessity, it just usually follows in contexts that involve normal conversational conditions.

A consequence of the theory of scalar implicatures is that the basic semantics of a word like "some" is a weak one: before it is pragmatically strengthened, it is consistent with the stronger statement using "all" being true. This has wide-spread effects on what we consider to be meaning throughout language because scalar implicatures do not just apply to the case of <all, some>; on the contrary, a wide variety of words in English and other natural languages are given this type of semantic/pragmatic analysis: negative quantifiers <no, few>, numbers <... four, three, two, one>, temperatures <hot, warm>, verbs <love, like>, modals <must, may>, among others including Grice's original

example of logical connectives <and, or>. In each, the weaker terms (e.g. "some", "few", "warm", "like", "may", "or") have as their basic semantics a meaning consistent with the stronger term being true, but they are pragmatically strengthened with the implicature that the stronger term is false.

The theory of scalar implicature is supported by data showing that in fact sometimes the weak reading is exactly what is meant and understood. Compare the typical strong interpretations (shown in parentheses) of "some", "likes", and "or" in (2)-(4)a with the same words in (2)-(4)b-c, where it is more natural to interpret the words as compatible with the stronger term (illustrated in parentheses).

- (2) a. Mary ate **some** of the cookies.

(She did **not** eat **all** of them.)

- b. If Mary eats **some** of the cookies, she'll get in trouble.

(Mary will get in trouble if she eats **all** of the cookies too.)

- c. Everyone who eats **some** of the cookies will get in trouble.

(People will get in trouble who eat **all** of the cookies too.)

- (3) a. Mary **likes** soup.

(She does **not** **love** soup.)

- b. If Mary **likes** soup, she'll buy some.

(Mary will buy some if she **loves** the soup too.)

- c. Everyone who **likes** soup will buy some.

(People who **love** soup will buy some too.)

(4) a. Mary drank tea **or** coffee.

(She drank one or the other, but **not** tea **and** coffee.)

b. If Mary drank tea **or** coffee she'll get sick.

(She'll get sick if she drinks tea **and** coffee too.)

c. Everybody who drinks tea **or** coffee will get sick.

(People will get sick who drink tea **and** coffee too.)

Despite the different ways we interpret the terms in (2)-(4)a and (2)-(4)b-c, we don't want to say that each of these terms is ambiguous, because that would be missing the generalization that each term is "ambiguous" in exactly the same way. The theory of scalar implicatures has the happy consequence of reducing the need for positing vast ambiguity between the weak and strong readings of terms like *some* and *or* throughout the language: each term has a single weak reading, and under normal conversational conditions they are strengthened via scalar implicature. Note that in cases where the weak reading is preferred (e.g. (2)-(4)bc), the scalar terms were in special sentence structures such as conditionals (2)-(4)b or the relative clause following "every" (2)-(4)c. Why and how this difference causes the effect that it does in scalar implicatures is the subject of a lively debate in the semantics/pragmatics literature (Russell 2006; Chierchia et al. to appear), but clearly in cases like (2)-(4)bc the scalar implicature would actually *weaken* the overall statement, and so it is not drawn; only in cases when it would strengthen the statement as in (2)-(4)a does the implicature come about.

Further evidence supporting the theory of scalar implicature comes from controlled psycholinguistic experiments. Participants take longer to respond in behavioral

and eye-tracking experimental tasks when they must calculate scalar implicatures than where they don't (Bott & Noveck 2004; Storto & Tanenhaus 2005) and they also have more difficulty calculating scalar implicatures when their processing load is increased by a concurrent task such as memorizing dot patterns (De Neys & Schaeken 2007).

Preschool and early elementary school children show much less scalar implicature calculation than adults (Noveck 2001; Chierchia et al. 2001; Papafragou & Musolino 2003, among others), despite generally being fluent in their language.

Since Horn (1989), many analyses of scalar implicature have relied on the assumption that adults have learned what words contrast with each other in a "scale", in order to appropriately generate the alternative to consider. For example, in (1), the listener hears *some* and knows that <all, some> form a scale, so they consider as an alternative the statement containing "all", and reason that it must not be true. What happens in the reasoning stage is under debate: some consider that when "some" is heard there is an automatic inference (Levinson 2000) or a grammatical computation (Chierchia 2006; Chierchia et al. to appear) that occurs, while others suggest that the hearer first computes the logical meaning of the entire sentence and then considers norms of conversation to determine its pragmatic meaning (Russell 2006; van Rooij and Shultz 2004). An important distinction between the first two of these theories and the third is the role of the scale itself, and what it means to know a scale: what is the relationship between meaning and form when it comes to a scale? Must scalemates be constrained as some have suggested syntactically (Katzir 2007) or morpho-phonologically (Matsumoto 1995)? Does the contrasting phonological form of the scalemates matter?

Certainly there are some constraints on the form of members in a scale: consider the hypothetical scale <only some, some>. These scalemates follow the semantic requirements for a scale, because a positive statement with "only some" is strictly stronger than the same statement replaced with "some": "Mary ate only some of the cookies" entails that "Mary ate some of the cookies." However, the negation of the stronger alternative (i.e.(5b)) is not implicated when we hear (5a)- in fact, (5b) is the opposite of what most people would conclude from (5a).

- (5) a. Mary ate **some** of the cookies.
 b. Mary did **not** eat **only some** of the cookies.

This suggest some importance to the grouping of terms into a "scale" like <all, some> and not other possibilities like <only some, some>. Unfortunately, any research on this topic has been restricted to the only a few well-studied spoken languages, which can limit the types of scales that one can investigate. If we fail to expand the study of scalar implicatures to other languages, or even another language modality, we risk missing a deeper understanding of the way that we reason about quantities and pragmatics.

In this paper, I investigate for the first time whether and how scalar implicatures are computed in a sign language, taking advantage of unique aspects of the visual/manual modality of sign languages to investigate the general question of how scales are constrained. I compare a prototypical scale of (a) quantifiers in English and in ASL with two other scales in each language: (b) numbers and (c) an *ad hoc* scale.

Quantifiers.

Two ASL quantifiers, SOME and ALL (Figure 2.1), served here as the prototypical test case for scalar implicatures in a sign language because they make no special use of spatial classifiers, and are also usually translated straightforwardly into English as "some" and "all". Given their similarities with the English quantifiers, and the fact that similar quantifiers in other languages typically pattern alike (Noveck 2001; Papafragou & Musolino 2003, among others), these were expected under a working experimental paradigm to generate behavioral results similar to results based on the <all, some> scale in English.

SOME

ALL

Figure 2.1: SOME and ALL used in the Quantifier sentence type.

Numbers.

In experimental research on scalar implicatures in spoken languages, numbers (specifically, the natural numbers <..., three, two, one>) are more consistently rejected in underinformative situations than quantifiers by adults, and also by children who fail to generate scalar implicatures for prototypical scales like quantifiers. Some have taken this to be an indication that the "strengthened" meaning of numbers is not pragmatic but semantic (Papafragou & Musolino 2003), while others have taken it to mean that

pragmatic strengthening is more robust in numbers because the numbers scale is more salient than other scales (Barner et al. 2010).

The current paper tested numbers in ASL to add a new dimension to this debate, because in ASL the numerals *one* through *five* are comprised of a handshape configuration in which the number of extended fingers is equal to the meaning of the sign (Figure 2.2). Consequently, there is a more transparent mapping between the form and the meaning in ASL numerals. Note that the signs themselves are both fixed and arbitrary, in that the sign for *three* must include the thumb, and not the ring finger, as shown in Figure 2.2. We currently know very little about the effects of increased transparency in meaning on pragmatic interpretation, and so this scale was included to test whether this property found more frequently in the visual-manual modality alters implicature calculation. Numbers are usually already rejected when used in underinformative situations, so we will only see a difference if implicatures are decreased. We also included numbers because they are such a frequently studied scale in spoken languages, and a high and accurate rejection rate by participants on numbers in ASL and English would indicate success of the experimental paradigm.

TWO

THREE

Figure 2.2: TWO and THREE used in the Number sentence type.

Ad hoc Scale.

Both sentence types described above, quantifiers and numbers, are based on scales that are generalizable to a variety of contexts, i.e. ALL is an alternative to SOME in most situations and THREE is an alternative to TWO in most situations. The third sentence type investigated in this experiment was an ad hoc scale, in which the scalemates are alternatives *because* of the given context, and the relationship is not generalizable. For example, in a situation (actually, one of the ones used in the current experiment) where a candle, a globe, and a wallet are three relevant objects, then "candle, globe, and wallet" is a salient alternative to "candle and globe", and (6a) implies (6b).

- (6) a. There is a candle and a globe on the table.
 b. There is not a wallet on the table.

In a different situation in which the three relevant items on the table are a candle, a globe, and a sock, then "candle, globe, and wallet" is no longer a salient alternative to "candle and globe," and we do not draw the implicature in (6b).

Note that these ad hoc scales differ from prototypical scales not only in being specific to the context, but in that the alternatives are not single lexical items (e.g. <and, or>) but constituents made up of a number of different words (<(candle, globe and sock), (candle and globe)>). Understanding how such a scale works in English allows us to determine the role of these two properties in scalar implicature calculation.

Such ad hoc scales are even more of interest in ASL because a natural way to sign a description of three items on the table as in (6) is to use the spatial/location classifier system. This system is unique to signed languages, and takes advantage of the manual/visual modality to include information about the size and spatial layout of the objects and space being described. There are many ways in which to use this system, particularly in narratives. Although the meaning/form relationship is especially transparent in the classifier system, the system is very much still linguistic, for example, handshapes are constrained to a finite list, and each object is matched with an obligatory specific handshape (Sandler & Lillo-Martin 2006). By comparing ad hoc scales in ASL to ad hoc scales in English, we can assess whether information about space (not directly related to quantity) affects pragmatic interpretation (a stronger implicature in ASL would suggest that it does) or, if because space is not directly related to quantity, there is no additional effect of spatial information (which would be the case if ad hoc implicatures in ASL and in English are calculated at similar rates).

The ad hoc scale-based sentences in this experiment began with a deictic sign (THERE) and then each item in the list was signed in its citation form in neutral space, followed by a location classifier (notated "CL", following Sandler & Lillo-Martin 2006) to indicate both the size and shape of the item (notated by what follows the colon, which indicates the handshape, e.g. "B", "C", "C(claw)") and where in the space the item was located (notated using variable subscripts, e.g. "X", "Y", and "Z"). For example, in (7), the signer uses two signs THERE and WALLET, and then a spatial classifier which has a B handshape to represent the wallet, placed in the first location ("X"). This is followed by the sign CANDLE and a classifier with the C handshape to represent the candle, placed

in location Y. Finally, this is followed by the sign GLOBE followed by a classifier in the clawed 5 handshape, placed in location Z. The "scalar item" (everything following the deictic) is also shown frame-by-frame in Figure 2.3.

(7) THERE WALLET CL:B_X CANDLE CL:C_Y GLOBE CL:5(claw)_Z

"There is a wallet, a candle, and a globe."

To be clear, there are multiple ways to incorporate the spatial classifier system in ASL into sentences involving implicatures (even multiple ways for ad hoc implicatures) but here the goal was to show one of these ways, and to test whether and how this affected pragmatic interpretation.

Since experimental pragmatics has yet to take on the study of sign languages, one of the goals of investigating this sentence type is to see whether the addition of the information about the spatial relationship of objects affects pragmatic interpretation. If it does, we may see more implicature calculation in the ad hoc sentence type in ASL than in English. If, however, it does not play a role pragmatic calculations like quantity implicatures, then we expect to see equal implicature calculation in Ad hoc sentence test trials in ASL and in English.

CANDLE CL:C_Y GLOBE CL:5(claw)_Z

WALLET CL:B_X CANDLE CL:C_Y GLOBE CL:5(claw)_Z

Figure 2.3: Two item and three item trials used in the Ad hoc sentence type.

The structure of ASL thus provides three contexts in which to assess different properties of scalar implicatures: (i) a prototypical scale <all, some> to determine whether scalar implicatures occur in a signed language in the same frequency and pattern that they occur in spoken language; (ii) a scale with increased transparent mapping between meaning and form to determine if this affects pragmatic interpretation, using the

numbers scale in ASL <"three", "two"> ; and (iii) spatial classifiers to determine if size, shape, and location can affect pragmatic interpretation, using a non-generalizeable context-dependent ad hoc scale in ASL. All of these allow us to begin to understand how sign language pragmatics compares and contrasts with spoken language pragmatics to create a model for future studies, and also to investigate the nature of a semantic scale in general by determining if it can be influenced by factors such as increased transparency in meaning and by the addition of spatial information.

Methods

Participants

Participants were twenty adults from the greater San Diego area. Eight were adults who self-identify as deaf and have been learning and using American Sign Language since birth because they had at least one deaf parent. All were unable to hear normal speech, and all used ASL in their home, at work, or both. These participants were recruited directly through email requests from a laboratory database of interested participants or indirectly through recommendations by their friends. All received reimbursement in cash or gift cards. I will refer to these eight participants as "native signers of ASL". The twelve remaining participants were hearing undergraduate students at the University of California who were native speakers of English and had no exposure to ASL. These participants received course credit for participating in the experiment. I will refer to these participants as "native speakers of English."

Procedures and Stimuli

Each testing session lasted 30-35 minutes. The participant sat in front of a 13 inch Macbook laptop on a table, either at UCSD or, for some native signers of ASL, at various meeting places throughout San Diego county. Both the instructions and the task itself were presented on the laptop in video form, by a native signer of ASL (ASL version) or a native speaker of English (English version). Participants were instructed that for each trial of the experiment, a picture will appear on the screen, and that after they look at the picture, they should press the Space Bar key and a video description will begin to play next to the picture. Participants were told to press the smile face (the "1" key covered with a smile face sticker, directly below the picture of a smile face on screen) if they are "satisfied that the description matches the picture." If they are "not satisfied, and think that the description does not match the picture", they were instructed to press the frown face (the "0" key covered with a frown face sticker, directly below the picture of the frowning face on screen) (Figure 2.4). It was impossible in both the ASL version and in the English version to replay a video.

Participants viewed three practice trials to acquaint them with the task: (1) a picture of a red bowl, and a video description (*THAT BOWL, RED* "The bowl is red"); (2) a picture of a white shoe, and a video description (*THAT SHOE, BLACK* "The shoe is black"); (3) a picture of a wooden spoon, and a video description (*THAT SPOON, WOODEN* "The spoon is wooden"). Participants had an opportunity to ask questions at this point if anything about the task or playing the videos was unclear. Practice trials were followed by further instructions, and a confirmation that the task was understood. Finally, 48 trials were presented, of which 12 were unrelated to the current experiment and 36

were experimental trials consisting of 3 sentence types: (a) quantifiers; (b) numbers; and (c) ad hoc scales. Responses were recorded using Psyscope software.

Figure 2.4: Screenshot during an ASL Number experimental trial. The picture is always on the left, and the signed description of the picture appears on the right after the Spacebar key is pressed.

In the quantifier trials, each picture consisted of a set of objects of which either some of them or all of them fulfilled a characterization about that object (red cans, lit candles, full glasses, etc.) A schema is shown in Figure 2.5, and the entire list is in the Appendices. Under the **Match** condition, the characterization applied to all of the objects (e.g. three cans, all red), and the description was accurate (e.g. *CANS, ALL RED* "All of the cans are red."). Under the **Mismatch** condition, the characterization applied to a proper subset of the objects (e.g. three cans, only two are red), and the description was not accurate (e.g. *CANS, ALL RED* "All of the cans are red."). Finally, under the **Test**

condition, the characterization applied to all of the objects (e.g. three cans, all red), and the description was not maximally informative (e.g. *CANS, SOME RED* "Some of the cans are red."). In this way, the weak scalar term *SOME* was only evaluated by participants in the Test condition, so that they were never directly comparing use of the term in this condition to use of the term when it was maximally informative. Trials for Quantifiers, Numbers, and the Ad hoc scale were counterbalanced so that each sentence frame (e.g. red cans) appeared in only one trial type (Match, Test, Mismatch) for each participant, and each third of participants saw the sentence frame in a different trial type.

In the number trials, each picture consisted of a set of either two or three of the same kind of object (animals, pencils, etc.). Again, a schema is shown in Figure 2.5, and the entire list is in the Appendices. In the **Match** condition there were three objects, and the description was accurate (e.g. *BEARS, HAVE THREE* "There are three bears"). Under the **Mismatch** condition, there were only two objects, but the description said there were three (e.g. *BEARS, HAVE THREE* "There are three bears"). Finally, under the **Test** condition, there were three objects, and the description was not maximally informative (e.g. *BEARS, HAVE TWO* "There are two bears").

In ad hoc trials, each picture consisted of a set of either two or three different kinds of objects (a wallet, a candle, and possibly a globe, for example). Again, a schema is shown in Figure 2.5, and the entire list is in the Appendices. In the **Match** condition in these trials, there were three different objects, and the description was accurate (e.g. *THERE WALLET CL:B_X CANDLE CL:C_Y GLOBE CL:5(claw)_Z* "There is a wallet, a candle, and a globe."). Under the **Mismatch** condition, only two of these objects appeared in the picture, but the description was the same as the Match condition,

indicating that there should be three (e.g. *THERE WALLET CL:B_X CANDLE CL:C_Y GLOBE CL:5(claw)_Z* "There is a wallet, a candle, and a globe."). Finally, under the **Test** condition, there were three different objects in the picture (just like in the Match condition), and the description was not maximally informative (e.g. *THERE CANDLE CL:C_Y GLOBE CL:5(claw)_Z* "There is a candle and a globe.").

Figure 2.5: Design of 36 experimental trials, shown in English: 12 Quantifier trials, 12 Number trials, 12 Ad hoc trials

Results

In the prototypical scale of quantifiers, native speakers of English accepted the control Match sentences 100% of the time, and rejected the control Mismatch sentences 100% of the time, a clear indication that the task was understood (Table 2.1). The quantifier Test condition assessed scalar implicature calculation: recall that without the strengthened scalar implicature reading both the Test and the Match conditions are true and should thus be accepted. Under the scalar implicature reading, however, the Test case should be rejected. Consistent with previous research, in this experiment native speakers of English showed significantly more rejection (i.e. indications with the frown face) of Test sentences than the control Match sentences ($t(11)=7.10$, $p<0.0001$). This higher rate of rejection of the Test sentences by native English speakers indicates that they were drawing scalar implicatures as we would expect from previous research.

Table 2.1: Mean rejection rates for each sentence type in English and in ASL

		Match	Mismatch	Test
English	Quantifiers	0	1	0.77 (0.38)
	Numbers	0	1	0.96 (0.14)
	Ad Hoc	0	1	0.54 (0.45)
ASL	Quantifiers	0.19 (0.18)	1	0.84 (0.23)
	Numbers	0	1	1
	Ad Hoc	0.09 (0.19)	1	0.88 (0.35)

Similarly for numbers, native speakers of English accepted the Match sentences 100% of the time, and rejected the Mismatch sentences 100% of the time. There was also significantly more rejection of the Test case than the Match case for Numbers ($t(11)=23.00$, $p<0.0001$), indicating a strong, exact interpretation of the numbers. Together with the quantifier results, these findings indicate that the experimental paradigm was successful, as participants' rejection rates on both scales are in line with previous quantitative behavioral results for adult scalar implicature calculation in spoken languages ($M=0.77$, $SD=0.37$ for quantifiers, $M=0.96$, $SD=0.14$ for numbers).

In ASL, control Match trials varied somewhat more than the 100% trials in English, but were still accepted at a high rate ($M=0.81$, $SD=0.18$), and 100% of the Mismatch trials were rejected. As for the Test case of scalar implicatures, in ASL there was also significantly more rejection of Test quantifier sentences than the control Match sentences ($t(7)=6.25$, $p<0.001$) among signers, an indication that at least for a prototypical scale like quantifiers, scalar implicatures occur in ASL just as in spoken languages. Similar results were obtained for the Numbers scale, where native signing participants accepted 100% of the Match trials, rejected 100% of the mismatch trials, and -crucially- rejected 100% of the test trials.

As for the ad hoc scale, in English the Match condition was accepted 100% of the time and the Mismatch condition was rejected 100% of the time. Participants rejected the Test case significantly more often than the control Match case in English ($t(11)=4.17$, $p<0.001$). These results indicate that ad hoc implicatures do appear in a felicity judgment task, despite being contextually dependent and not based on two contrasting words. However, their interpretations seem to be of a more flexible nature than the other scales:

there were quantitatively less implicatures drawn on the ad hoc scale than quantifiers ($M=0.54$ for ad hoc compared to $M=0.77$ for quantifiers), and significantly less than the number scale ($t(11)=3.25$, $p<0.01$).

In the ad hoc scale in ASL, the Match condition was also overwhelmingly accepted ($M=0.91$, $SD=0.19$) and the Mismatch case was rejected 100% of the time, while participants rejected the Test case significantly more often than the control Match case in ASL ($t(7)=6.06$, $p<0.001$). Comparing ASL to English, there is a marginally significant difference in rejection rates of test sentences between the ad hoc scale in ASL and in English ($t(18)=1.76$, $p=0.09$), the only scale showing any indication of a difference: on the quantifier scale there was no significant difference in rejection rates of test sentences between English and ASL ($t(18)=0.49$, $p>0.1$) and the same also holds for numbers ($t(18)=0.81$, $p>0.1$). A visual representation of the Test trial accuracy for each sentence type in ASL and English can be found in Figure 2.6.

Figure 2.6: Accuracy (rejection rates) on the Test trial types for each sentence type in English and in ASL

Discussion

Results of this experiment regarding the calculation of scalar implicatures in ASL found that for a prototypical scale like quantifiers, ASL patterns just like English: native signers reject these inferences more than they reject true sentences, and no significant differences were found between the languages on the quantifier scale. In a less prototypical scale, numbers, there was also no significant differences found between the two languages: a high rejection rate of the test cases was found both in ASL and in English. Not only does this study confirm that native signers in ASL do reject underinformative descriptions and thus compute implicatures, but they do it in a very similar pattern to native speakers of English. Participants' behavior on both the quantifier

and number sentence types suggests that when there is no difference in semantic content being conveyed, there is also no difference in pragmatic behavior in ASL and in English. The transparent mapping of the form of the sign for numbers "one" through "five" in ASL had no effect on participants' interpretation of sentences using the terms. We conclude that native signers of ASL compute scalar implicatures and interpret number words just like native speakers of English, showing no effect of transparency in meaning.

Results on these two scales are consistent with previous findings of similarities of scalar implicatures calculations cross-(spoken)linguistically, and allow us to add semantic/pragmatic phenomena to the list of formal linguistic structures which are similar in both signed and spoken languages. It also allows us to set a baseline by which to ask questions about scalar implicature calculation that are unique to signed languages. One of these questions is whether deaf nonnative signers also compute scalar implicatures like native signers. Deaf nonnative signers constitute approximately 90% of the deaf population in the U.S, but since their families do not sign, they often do not receive linguistic input until later, for example when they attend school. Unfortunately, this population often exhibits deficits in linguistic processing (Mayberry 2010). Although the question has been posed (Siegal & Surian 2004), no one has previously studied these individuals' semantic and pragmatic abilities on a task like scalar implicatures. Scalar implicatures are of particular interest to be studied in deaf late learning signers due to a recent discussion in the literature about whether implicatures should be accounted for as part of our linguistic knowledge or part of a subset of social skills (Levinson 2000, Russell 2006, Chierchia et al. to appear). Since nonnative signers are considered to be cognitively normal but do not learn ASL in a native fashion, they form a test case for

determining whether implicature calculation is more tied to a person's linguistic competence or competence in general social and other cognitive skills. In Davidson and Mayberry (Chapter 4, this dissertation), this question is addressed with an experiment using a similar testing paradigm to the one used in the current study.

The one marginal difference found in the results presented here between English and ASL was in the case of sentences based on the ad hoc scales, where there were slightly more implicatures drawn based on ad hoc scales in ASL than ad hoc scales in English. The only difference between sentences in ASL and the English was the addition of information about the spatial layout in ASL. In particular, despite the same basic word order, the overlay of the spatial information was enough to encourage quantitatively more rejections of underinformative descriptions in ASL than in English. The same participants rejected quantifier and number scales at the same rate as their English counterparts, so this difference cannot be seen as an overall preference for rejection. Instead, it suggests that the additional information conveyed about space through the classifier system may have an effect on signers' pragmatic behavior.

The next step in this investigation is to ask why space might play a role in pragmatic interpretations. One possible explanation is that the addition of spatial information influences participants' perception of the issues that are at stake. A helpful framework for considering this idea is the Question Under Discussion framework (Roberts 1998, Buring 2003), which models a conversation as a series of questions and answers, so that each declarative statement is evaluated as a response to an (often implicit) question. For example, the English sentence "There is a wallet and a globe" could be likely answering the question "What is on the table?" or "What exists in this

room?" In ASL, the use of locational classifiers could bias the possible question to be along the lines of "What configuration are the things on the table in?" In English, we could get a similar effect by adding spatial information as in (8).

(8) There is a wallet on the left side of the table and a globe on the right side of the table.

The difference seems to be between describing a scene and mentioning a few items. This isn't to say that the English sentence couldn't answer the same questions under discussion as the ASL sentence, but that the addition of spatial information may bias the possible questions under discussion that one is likely to be answering.

It could also be the case that the more specific information that is added to a sentence, the more that it is taken to be a full description of the situation. A less specific description (e.g. the English description) might be considered less likely to be a full description of the situation. Put a different way, it could be the case that when signers describe the spatial layout in the manner done in the ASL ad hoc scales in this experiment, there is an accompanying requirement/operator that the space be described to a full ("exhaustive") extent. For example, in English, one can easily add exhaustifiers like "only" to a sentence to ensure that it receives an exhaustive interpretation (9).

(9) There is only a candle and a globe.

(It is not the case that there is a wallet, a candle, and a globe.)

Perhaps using the spatial system in ASL has a similar effect to adding "only" in English, triggering the meaning to be exhaustified similarly to the "O" operator in Chierchia et al. (to appear).

Recall that the ad hoc scales used in both languages in this experiment are semantically similar to a Horn scale (e.g. quantifiers) in that one expression is strictly stronger than another when replaced in a positive sentence frame like those used in the experiment. Just as *Some of the cans are red* is weaker than *All of the cans are red*, so is *There is a wallet and a candle* weaker than *There is a wallet, a candle, and a globe*. However, recall that the ad hoc and Horn scales differ in two important respects. First, salient opposition of the items in the scale <all, some> is generalizable to any context: in many (if not all) cases where "some" is used, "all" is a relevant alternative. Secondly, it is also the case that the alternatives in the Horn scales are each lexicalized in a way that is not true for the ad hoc scale: "wallet, candle, and globe" is strictly speaking not as easy to say as "wallet and candle", while "all" and "some" are equally easy to say because they are each a single lexical item (Matsumoto 1995, Levinson 2000). Understanding the reason for the relative weakened implicatures for ad hoc scales in English compared to ASL would benefit from future work to dissociate these two possibilities. In Davidson (Chapter 3, this dissertation), this is done by investigating a scale in ASL which is generalizable but is not based on two distinct lexical items: one form of the <and, or> scale in ASL.

Overall, results of this paper show similar calculation of scalar implicatures in ASL and in English. One potentially complicating issue to consider in this and any ASL research is the extent of is bilingualism among educated signers. Because the native

signers of ASL are living in the United States and have had many years of education, they are all bilingual to some extent in English. This could be relevant because young Slovenian/Italian bilingual children were shown to have an advantage over their monolingual counterparts in tests of pragmatic conversational skills (Siegal et al., 2009), and in second language acquisition studies of scalar implicatures, there is usually transfer from the participant's first language (Siegal et al. 2007, Slabakova 2010). In the future it would be informative to also include tasks that test signers' proficiency in English, because even native signers of ASL may also consider themselves bilingual in various forms of English.

In addition to understanding scalar implicatures in ASL, another goal of this work was to create a paradigm for investigating the semantic/pragmatic interface in signed languages. I suggested that one effective method of gathering quantitative data on pragmatic behavior is to create an experiment on a laptop: this can be brought to more than one location to enhance recruitment of deaf participants. Using non-linguistic based input (here, smile and frown faces) also removes some of the spoken/written language influence out of the computer interface. Finally, working with a native signer both to sign the stimuli and also, if the experimenter is not a native signer, to join in testing sessions is suggested. Future research using this paradigm could investigate various other semantic/pragmatic phenomena in ASL, such as presupposition and especially other types of implicatures.

The current stage of sign language linguistics research is such that we now know many ways in which sign language structure is similar to spoken language structure: they have a phonology, a syntax, a semantics, and as the current work shows, even similar

pragmatic behaviors. This once surprising analogy between signed and spoken languages is becoming an established norm in linguistics, and that is certainly an excellent advancement. However, the next stage of questions is likely to be equally surprising: what are the unique aspects of communicating via natural language in the visual/manual modality, and what can they tell us about the human capacity for language in general? Based on the findings presented here concerning spatial classifiers in ad hoc scales, it will hopefully be the case that semantics/pragmatics will be a part of this research.

Acknowledgements

Much gratitude to Ivano Caponigro, Rachel Mayberry, Brandon Scates, Marla Hatrak, Jeff Zaremba, Cami Miner, Corinne Brion, Carol Padden, Matt Hall, Susan Fischer, Peggy Lott, audiences at ESSLLI 2009 in Bordeaux, Gallaudet Brown bag lunch, Masha Polinsky's Language Sciences at Harvard, CRL at UCSD, members of the UCSD Multimodal Language Development lab, and UCSD Semantics Babble. Funding for this project was provided by the UCSD Linguistic Department Research grant and by the National Institute of Health predoctoral training grant #T32DC000041 through the Center for Research in Language at UCSD. This chapter, in full, is currently being prepared for submission for publication of all of the material presented here. [Davidson, Kathryn]. The dissertation author was the primary investigator and author of this material.

Appendix 1: Stimuli for the English version of the Experiment**Quantifiers**

All/Some of the balls are yellow.

All/Some of the books are open.

All/Some of the candles are lit.

All/Some of the cans are red.

All/Some of the pencils are broken.

All/Some of the bowls are yellow.

All/Some of the cards are black.

All/Some of the glasses are full.

All/Some of the hangers are brown.

All/Some of the shoes are black.

All/Some of the socks are brown.

All/Some of the spoons are wooden.

Numbers

There are three/two bears.

There are three/two bowls.

There are three/two candles.

There are three/two cereal boxes.

There are three/two cups.

There are three/two cans of juice.

There are three/two markers.

There are three/two movies.

There are three/two mugs.

There are three/two pencils.

There are three/two shoes.

There are three/two spoons.

Ad hoc

There is a bottle, a oven mitt, and a book./ There is a bottle and an oven mitt.

There is a bowl, a movie, and sunglasses./ There is a bowl and sunglasses.

There is a cereal box, a can, and a measuring cup. / There is a cereal box and a can.

There is a football, a show, and a can./ There is a football and a can.

There is a glass, a plate, and a bowl. /There is a glass and a bowl.

There is a knife, a fork, and a spoon./ There is a fork and a spoon.

There is a marker, sunglasses, and a ball. / There is a marker and a ball.

There is a marker, a towel, and a wine glass. / There is a marker and a towel.

There is a red cup, a can of juice, and a spoon./ There is a can of juice and a spoon.

There are scissors, a bear, and a ruler. / There are scissors and a bear.

There is a shoe, a measuring cup, and a pineapple. / There is a measuring cup and a
pineapple.

There is a wallet, a candle, and a globe./ There is a candle and a globe.

Appendix 2: Stimuli for the ASL version of the Experiment

Quantifiers (N.B. the first noun is topicalized with brown raising nonmanual marking)

BALL, ALL/SOME YELLOW.

BOOKS, ALL/SOME OPEN.

CANDLE, ALL/SOME LIT.

CAN, ALL/SOME RED.

PENCIL, ALL/SOME BROKE.

BOWL, ALL/SOME YELLOW.

(Playing)CARD, ALL/SOME BLACK.

CUP, ALL/SOME FULL.

HANGER, ALL/SOME BROWN.

SHOE, ALL/SOME BLACK.

SOCK, ALL/SOME BROWN.

SPOON, ALL/SOME WOODEN.

Numbers

BEAR THERE THREE/TWO.

BOWL THERE THREE/TWO

CANDLE THERE THREE/TWO

CEREAL BOX THERE THREE/TWO

CUP THERE THREE/TWO

JUICE CAN THERE THREE/TWO

COLOR MARKER THERE THREE/TWO

MOVIE THERE THREE/TWO

COFFEE CUP THERE THREE/TWO

PENCIL THERE THREE/TWO

SHOE THERE THREE/TWO

SPOON THERE THREE/TWO

Ad hoc (N.B. "CL" indicates a classifier construction; the symbol following the colon

indicates the handshape of the classifier construction; the subscripts indicate

placements to the left "X", center "Y" and right "Z" of the signer)

THERE METAL CUP CL:C_X, OVEN GLOVE CL:B_Y, BOOK CL:B_Z. /

THERE METAL CUP CL:C_X, OVEN GLOVE CL:B_Y.

THERE BOWL CL:C(reduced)_X, MOVIE CL:G_Y, GLASSES, CL:C(reduced)_Z. /

THERE BOWL CL:C(reduced)_X, GLASSES, CL:C(reduced)_Z.

THERE CEREAL BOX CL:C(reduced)_X, CUP CL:C_Y, CUP MEASURE CL:C_Z. /

THERE CEREAL BOX CL:C(reduced)_X, CUP CL:C_Y.

THERE FOOTBALL BALL CL:C_X, SHOE CL:B_Y, CUP CL:C_Z. /

THERE FOOTBALL BALL CL:C_X, CUP CL:C_Z.

THERE GLASS CUP CL:C_X, PLATE CL:C(reduced)_Y, BOWL CL:C(reduced)_Z. /

THERE GLASS CUP CL:C_X, BOWL CL:C(reduced)_Z.

THERE KNIFE CL:U_X, FORK CL:U_Y, SPOON CL:U_Z. /

THERE FORK CL:U_Y, SPOON CL:U_Z.

THERE COLOR PEN CL:1_X, GLASSES CL:C(reduced)_Y, BALL CL:5(claw)_Z. /

THERE COLOR PEN CL:1_X, BALL CL:5(claw)_Z.

THERE COLOR PEN CL:1_X, TOWEL CL:B_Y, WINE CUP CL:C_Z. /

THERE COLOR PEN CL:1_X, TOWEL CL:B_Y.

THERE RED CAN CL:C_X, DRINK CUP CL:C_Y, WOODEN SPOON CL:U_Z. /

THERE DRINK CUP CL:C_Y, WOODEN SPOON CL:U_Z.

THERE SCISSORS CL:V_X, BEAR CL:C_Y, RULER CL:U_Z. /

THERE SCISSORS CL:V_X, BEAR CL:C_Y.

THERE SHOE CL:B_X, CUP MEASURE CL:C_Y, PINEAPPLE CL:5(claw)_Z. /

THERE CUP MEASURE CL:C_Y, PINEAPPLE CL:5(claw)_Z.

THERE WALLET CL:B_X, CANDLE CL:C_Y, GLOBE CL:5(claw)_Z. /

THERE CANDLE CL:C_Y, GLOBE CL:5(claw)_Z.

References

- Barner, D., Brooks, N., & A. Bale (2010). "Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference." *Cognition* 118(1), 84-93.
- Bott, L. & I. Noveck. (2004). "Some utterances are underinformative: The onset and time course of scalar inferences." *Journal of Memory and Language* 51(3). 437-457.
- Buring, D. (2003). "On D-Trees, Beans, and B-Accents." *Linguistics and Philosophy* 26(5). 511-545.
- Chierchia, G. (2006). "Broaden Your Views: Implicatures of Domain Widening and the "Logicality" of Language." *Linguistic Inquiry* 37(4). 535-590.
- Chierchia, G., Fox, D., & B. Spector (to appear) "The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics." in Portner, P., Maienborn, C. & K. von Stechow (eds.), *An International Handbook of Natural Language Meaning*, Mouton de Gruyter.

- Chierchia, G., Crain, S., Guasti, M. T., Gualmini, A., & L. Meroni (2001) "The Acquisition of Disjunction: Evidence for a Grammatical View of Scalar Implicatures," in A. H.-J. Do et al., eds., *BUCLD 25 Proceedings*, Cascadia Press, Somerville, Massachusetts.
- Davidson, K. (Chapter 3, this dissertation). "Coordination in ASL: a Study of the Role of Lexical Contrast in Scalar Implicatures"
- Davidson, K. & R. Mayberry (Chapter 4, this dissertation). "Age of First Language Acquisition Effects on Scalar Implicature Calculation"
- De Neys, W. & W. Schaeken (2007). "When people are more logical under cognitive load." *Experimental Psychology* 54(2). 128-133.
- Gazdar, G. (1979). *Pragmatics: Implicature, presupposition and logical form*. Academic Press: New York.
- Grice, H. (1967; revised and published 1989). *Studies in the Way of Words*. Harvard University Press, Cambridge, MA.
- Horn, L. (1989). *A Natural History of Negation*. University of Chicago Press: Chicago.
- Katzir, R. (2007). "Structurally-defined alternatives." *Linguistics and Philosophy* 30(6). 669-690.
- Levinson, S. (2000). *Presumptive Meanings: the theory of generalized conversational implicature*. MIT Press: Cambridge.
- Matsumoto, Y. (1995). "The conversational condition on Horn Scales." *Linguistics and Philosophy* 18(1). 21-60.
- Mayberry, R. (2010). "Early Language Acquisition and Adult Language Ability: What Sign Language reveals about the Critical Period for Language." In M. Marschark & P. Spencer (Eds.), *Oxford Handbook of Deaf Studies, Language, and Education- Volume 2*, 281-291.
- Noveck, I. (2001). "When children are more logical than adults: experimental investigations of scalar implicature." *Cognition* 78(2) 165-188.
- Papafragou, A. & J. Musolino (2003). "Scalar Implicatures: experiments at the semantics-pragmatics interface." *Cognition* 86(3). 253-282.
- Pfau, R. & J. Quer (2010). "Nonmanuals: their prosodic and grammatical roles." In Brentari, D. (ed.), *Sign languages (Cambridge Language Surveys)*. Cambridge: Cambridge University Press. 381-402.

- Roberts, C. (1998). "Information structure in discourse: Towards an integrated formal theory of pragmatics." Columbus: Ohio State Working Papers in Linguistics.
- Russell, B. (2006). "Against Grammatical Computation of Scalar Implicatures." *Journal of Semantics* 23. 361-382.
- Sandler, W. & D. Lillo-Martin (2006). *Sign Language and Linguistic Universals*. Cambridge: Cambridge University Press.
- Schlenker, P. (2011). "Quantifiers and Variables: Insights from Sign Language (ASL and LSF)". In Partee, B.H., Glanzberg, M., & Skilters, J. (eds), *Formal Semantics and Pragmatics: Discourse, Context, and Models. The Baltic International Yearbook of Cognition, Logic and Communication, Vol. 6*.
- Siegal, M., Matsuo, A. & C. Pond (2007). "Bilingualism and cognitive development: Evidence from scalar implicatures." in Y. Otsu, (ed.) *Proceedings of the Eighth Tokyo Conference on Psycholinguistics*, Hituzi Syobo, Tokyo. 265–280.
- Siegal, M. & L. Surian (2004). "Conceptual Development and Conversational Understanding." *Trends in Cognitive Sciences* 8(12). 534-538.
- Siegal, M., Iozzi, L., & L. Surian (2009). "Bilingualism and conversational understanding in young children." *Cognition* 110(1). 115-122.
- Slabakova, R. (2010). "Scalar implicatures in second language acquisition." *Lingua* 120(10). 2444-2462.
- Storto, G. & M. Tanenhaus (2005). Are scalar implicatures computed online? In E. Maeir, Bary, C. & Huitink (Eds.) In *Proceedings of Sinn und Bedeuting* 9, pp. 431-445, Nijmegen: Nijmegen Centre for Semantics.
- van Rooij, R. & K. Schulz (2004). "Exhaustive Interpretation of Complex Sentences." *Journal of Logic, Language, and Information* 13(4). 491-519.
- Zucchi, S. (2009). "Along the Time Line: Tense and Time adverbs in Italian Sign Language", *Natural Language Semantics*.

CHAPTER 3

Coordination in ASL: a Study of the Role of Lexical Contrast in Scalar Implicatures

Abstract

In American Sign Language (ASL), conjunction ("and") and disjunction ("or") are often conveyed by the same coordinators (transcribed as "COORD"). So the sequence of signs WANT TEA COORD COFFEE can be interpreted as "I want tea or coffee" or "I want tea and coffee" depending on contextual or world knowledge or other linguistic information such as prosodic marking and the addition of disambiguating lexical material. In this paper I describe for the first time the variety of ways in which ASL conveys disjunction. I then show that general use coordinators that appear in ASL can be a test case for understanding the role of lexicalization of scalar items in the semantic/pragmatic phenomenon known as *scalar implicature* by collecting quantitative data from 10 adult native signers of ASL and 12 adult signers of English using a Felicity Judgment paradigm. Results show that there is a significant difference in interpretation of the general use coordination scale in ASL versus a prototypical scale in ASL and versus coordination in English, suggesting that the appearance of contrasting lexical items does affect pragmatic interpretation.

Logical operators such as negation ("not"), conjunction ("and"), disjunction ("or"), and implication ("if...then") are some of the most basic building blocks for conveying meaning in natural language. Although these connectives are interrelated (for example, "**if A then B**" is equivalent to "[**not A**] **or B**"), we frequently think of these operators as necessarily being distinct, or even as direct alternatives to each other in the case of "and" and "or". However, this need not always be the case: in English, for example, the disjunctive coordinator "or" (1) can sometimes be interpreted as conjunction, shown by the paraphrase in parentheses.

(1) You can have coffee or tea.

(You can have coffee and you can have tea.)

In this paper I look at the relationship of conjunction and disjunction in American Sign Language (ASL). Among the various methods ASL makes use of to convey disjunction, two very common strategies are general use coordinators which can be interpreted as either disjunction or as conjunction, depending on the linguistic and extra-linguistic context. In the second half of the paper, I present quantitative data from a felicity judgment experiment showing how this way of lexicalizing conjunction and disjunction in ASL can contribute a unique type of data for the study of scalar implicatures. This paper is intended to be accessible to both specialists in semantics/pragmatics and linguists who study sign language, so in some cases both formal and informal explanations may be given within the same discussion.

Most previous research on logical connectives in ASL has been limited to negation and implication, focusing primarily on their non-manual components (e.g. Baker & Padden 1978; Reilly et al. 1990; Anderson & Reilly 1998; Wilbur & Patschke 1999).¹ Surprisingly, there has been no mention in this literature of disjunction and conjunction, both of which are types of *coordination* (in this use of terminology I follow Haspelmath 2007). And in the most extensive typological study of coordination which included languages from Africa, the Caucasus, the Middle East, Southeast Asia, the Pacific, and the Americas (Haspelmath 2004), there were no data included from a sign language. One reason for this omission may be that at least on first glance in ASL, constituents like nouns and verbs are coordinated using a variety of different strategies that do not neatly divide into the contrast between conjunction versus disjunction. This means that simply identifying disjunction or conjunction isn't always an easy task. Another reason could be that, like negation and implicature, they also involve nonmanual components but in a somewhat less straightforward way, presenting a challenge for researchers. Finally, the lack of research on coordination could also be related to the small amount of formal sign language research in the fields of semantics/pragmatics. I argue in this paper using both traditional elicitation techniques and a quantitative experiment that there are multiple forms of coordination in ASL, and properties of some of these coordinators can

¹ Readers unacquainted with sign languages can compare nonmanual components to suprasegmental information like intonation in spoken languages: they occur concurrently with manual signs, and are used for marking questions versus statements and other grammatical purposes. Components of nonmanual marking typically consist of movements of the head, face, shoulders, and contrast with manual signs, which are roughly analogous to words in spoken languages and are signed with the hands.

contribute in unique ways to an important area of investigation in semantics and pragmatics.

To see why, consider the relationship between the meaning of disjunction and conjunction. Statements using disjunction are logically strictly weaker than statements using conjunction: if you know that Mary drank coffee and tea then strictly speaking it will also be the case that Mary drank coffee or tea. For perhaps a clearer judgment, imagine that a friend said one of the sentences in (2).

- (2) a. If Mary drinks tea or coffee, she's going to be sick, and should be taken to the hospital.
- b. Everyone who drinks tea or coffee will be sick and should be taken to the hospital.

Certainly, if you heard a sentence like (2a) or (2b) you would take Mary to the hospital if she had both tea and coffee! So, we can see in (2)a-b that for Mary to drink "tea or coffee," it counts if she drinks only tea, only coffee, and also if she drinks both. But in many cases when the disjunctive "or" statement is uttered as true in a context where the stronger conjunctive statement might be true as well, the stronger non-uttered statement involving conjunction is often implied to be false. This is why we usually understand "or" as meaning one or the other *but not both*: because people usually use disjunctions like "Mary drank coffee or tea" in precisely those cases where it would not be true for them to say that "Mary drank coffee and tea". So, saying "Mary drank coffee or tea" implicates that Mary drank coffee or tea but not both (Grice 1967; 1989). We can rephrase this in

semantic terms as saying that the basic meaning of "or" (the Inclusive Reading, used in (2)) is strengthened pragmatically (to create the Exclusive Reading of "either...or" that is usually the most natural interpretation of "Mary drank tea or coffee").

The strengthening of "or" to mean *one or the other but not both* is an example of a common pragmatic phenomenon known as a *scalar implicature*, when use of a weaker statement implies that the stronger statement is false. Disjunction and conjunction are just one example; another can be seen in "Some teas contain caffeine", which implies that "Not all teas contain caffeine." The most common analysis of scalar implicatures is that they arise because the only elements that differ between the two alternative sentences form a relationship (notated <and, or> and <all, some>) called a "scale" in which they are contrasted with each other and can be ordered based on the notion of entailment: if a sentence containing the weak term is true, then the same sentence with the stronger term must be true too (Gazdar 1979; Horn 1989).

One crucial question for this theory is what exactly it takes to become a "scale", i.e. how much the scalar items have to have in common and how they should be related to each other. Do the requirements for a scale concern the form of the scalar items, or are they based only on their meanings (that one must be strictly weaker than the other)? Many current pragmatic theories tend to follow the guidelines for scales summarized in Levinson (2000), in which scalemates need to be "in salient opposition: of the same form class, in the same dialect or register, and lexicalized to the same degree". As he says, this is to ensure that there should be no reason for choosing the weaker item on the scale other than the amount of information it conveys - this is what causes the implicature that the

stronger term is false to come about. In particular, for this reason the stronger term must be no harder to say than the weaker term (Matsumoto 1995).

This description of a scale predicts a scalar implicature interpretation as long as the weak and the strong term are equally easy to say and they are in the specified semantic relationships. In the second half of this paper, I test this hypothesis by investigating if a weak term is strengthened with a scalar implicature interpretation even when the expressions for both terms are lexically the same, i.e. they use the same word, where the meanings are distinguished through prosody and extra-linguistic context. ASL provides an intriguing test case for having exactly this type of arrangement in some forms of disjunction and conjunction, and can therefore help us better understand the role of lexical contrast in forming semantic scales.

3.1 Forms of Disjunction in ASL

As far as I am aware, no linguistic research has discussed how disjunction is conveyed in ASL, and how it compares to conjunction. In Part 3.1, I discuss five different linguistic forms that have appeared as ASL translations for English "or" in dictionaries of ASL. The most common way of translating "or" into ASL is by means of two general use coordinators. These are often interpreted as disjunction when additional lexical or prosodic material is added; otherwise, they are interpreted as conjunction ("and" in English). There is also a borrowing from English using fingerspelling of English "or." Though rare and considered to be part of an "old-style" of signing, disjunction can also be conveyed by means of a sign that looks identical to the wh-word WHICH 'which'.

Finally, there is a sign that is strongly related to disjunction and appears in disjunctive contexts but is not actually a coordinator. I discuss each in turn below.

For each form of translating disjunction, native ASL signer judgments were gathered on the use of that form in various sentence structures, including questions and two types of declarative statements, and in coordinating various types of constituents. The primary source consulted for each judgment was a profoundly deaf signer whose grandparents, parents, and husband are all deaf, and all use American Sign Language. She is knowledgeable about linguistics and grammaticality judgments but was naive to the goal of the present work during the consultation phase. Each judgment was also confirmed by at least one other deaf signer, and although these signers were of various language backgrounds, all were fluent in ASL.

3.1.1 General Use Coordinators

Two types of coordination in ASL are able to be interpreted disjunctively or conjunctively, depending on the context. I transcribe each of these as COORD for "general coordination". The first, which I label COORD-L, illustrated in Figure 3.1, consists of the signer's dominant hand pointing with a G (or sometimes B) handshape to successive fingers on the non-dominant hand, beginning with the thumb. Possible number of fingers on the non-dominant hand range from two (the thumb and forefinger) to all five fingers, which is also the range of coordinated items that this strategy allows. Another name for this strategy of coordination is *List Buoy* (Liddell 2003) which conveys that the relationship between the coordinator and the coordinates can be thought of as one of support, in which COORD-L supports/buoys the coordination of the coordinates.

Figure 3.1. COORD-L , from <http://www.lifeprint.com/dictionary.htm>

Disjunctive and conjunctive interpretations are disambiguated by the context, nonmanual marking, and by linguistic material preceding or following the coordinator. In (3), the sentence containing the coordinator is followed by a partially elided clause (in technical terms, a clause whose complement is an embedded sluiced constituent interrogative introduced by a D-linked wh-word). This clause is compatible only with a disjunctive interpretation of the preceding coordination phrase, and it will also usually be signed with nonmanual marking specific to a disjunctive interpretation. On the other hand, the very open general question ‘What will happen?’, preceding the coordinator in (4), here favors a conjunctive interpretation of the coordination phrase, and there is no associated nonmanual marking. It is currently unclear whether the associated nonmanual marking for disjunction is obligatory when the surrounding context is already enough to disambiguate between conjunction and disjunction; what *is* clear is that when the context is not sufficient to disambiguate between these two uses, the nonmanual marking is obligatory for a disjunctive reading.

- (3) [HER² PARENTS WILL BUY HER CAR] **COORD-L** [SHE WILL TRAVEL],
DON'T-KNOW WHICH.

'Her parents will buy her a car or she will travel, I'm not sure which.'

- (4) HAPPEN? [HER PARENTS WILL BUY HER CAR] **COORD-L** [SHE WILL TRAVEL].

'What will happen? Her parents will buy her a car, and (then) she will travel.'

In English, "or" can be used in alternative questions, inclusive statements, and exclusive statements. When **COORD-L** is interpreted as disjunction, it can also appear in alternative questions (5a) using the appropriate nonmanual marking for such questions, in declarative statements that are interpreted exclusively, as seen in (3) and repeated below in (5b), and declarative statements interpreted inclusively, as illustrated by the addition of **MAYBE BOTH** (5c). Note that in each of these cases the linguistic additions (nonmanual marking for questions or lexical material in declarative statements) also serves to clarify that the coordination should be interpreted as disjunction, not conjunction.

- (5) a. [HER PARENTS WILL BUY HER CAR] **COORD-L** [SHE WILL TRAVEL]?

'Will her parents buy her a car, or will she [use the money to] travel?'

(Alternative question, possible answers: car, travel)

² For purposes of readability for a non-technical audience, indexicals in ASL are glossed with the closest English translation given the context. So, this sentence uses **HER** and **SHE** despite the fact that ASL does not distinguish gender or case in its pronouns.

- b. [HER PARENTS WILL BUY HER CAR] **COORD-L** [SHE WILL TRAVEL], (DON'T-KNOW WHICH)

'Her parents will buy her a car or she will travel, I'm not sure which.'

(Exclusive Statement)

- c. [HER PARENTS WILL BUY HER CAR] **COORD-L** [SHE WILL TRAVEL], (MAYBE BOTH)

'Her parents will buy her a car or she will travel, maybe both.'

(Inclusive Statement)

COORD-L can also connect predicates in each of those sentence types: alternative questions (6a), exclusive statements (6b), and inclusive statements (6c).

- (6) a. MARY [SWIM] **COORD-L** [RUN]?

'Does Mary swim or run?'

(Alt. question, possible answers: swim, run)

- b. MARY [SWIM] **COORD-L** [RUN], (DON'T-KNOW WHICH).

'Mary swims or runs, I'm not sure which.'

(Exclusive Statement)

- c. MARY [SWIM] **COORD-L** [RUN], (MAYBE BOTH).

'Mary swims or runs, and maybe both.'

(Inclusive Statement)

In all cases so far the ASL sign COORD-L in its disjunctive interpretation exhibits a distribution similar to English "or": it can be used to ask alternative questions, for exclusive statements and inclusive statements, and to connect both clauses and predicates/VPs. However, there appears to be one difference between COORD-L and English "or", and that is in the domain of prosody. For some (but not all) signers, the use of COORD-L is reported to feel too heavy prosodically to connect two small light nouns (7). This non-uniform acceptance among signers is notated as "%" before the examples.

- (7) a. %MARY HAVE [COFFEE] COORD-L [TEA]?

'Did Mary have coffee or tea?'

(Alt. question, can answer: coffee, tea)

- b. %MARY HAVE [COFFEE] COORD-L [TEA], (DON'T-KNOW WHICH).

'Mary had coffee or tea, I'm not sure which.'

(Exclusive Statement)

- c. %MARY HAVE [COFFEE] COORD-L [TEA], (MAYBE BOTH).

'Mary had coffee or tea, and maybe both.'

(Inclusive Statement)

Thus, COORD-L seems to share the syntactic and semantic properties of English coordinators, but may sometimes prefer a more restricted set of prosodic environments.

A second way to coordinate clauses, predicates, and nouns in ASL is to shift the body slightly (moving a combination of torso, head, and/or eyes) for each coordinated element and sign each of the coordinated items in separate places in the signing space. This strategy is notated as COORD-shift and shown in Figure 3.2. Like COORD-L, this strategy can be used in both disjunctive (8) and conjunctive (9) contexts. For ease of comparing this to other forms of disjunction I have transcribed it in the way that manual signs are transcribed (as a separate word in capital letters), when in reality it is just a change in position from one side of the body to the other; the placement of the notation 'COORD-shift' marks the timing of this change in location.

Figure 3.2: COORD-shift, from <http://www.lifeprint.com/dictionary.htm>

- (8) HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL,
DON'T-KNOW WHICH.

'Her parents will buy her a car or she will travel, I'm not sure which.'

- (9) HAPPEN? HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL.

'What will happen? Her parents will buy her a car, and (then) she will travel.'

COORD-shift can be used for alternative statements as well as both inclusive and exclusive readings in statements (10a-c), although signers report that ideally its use in alternative questions would also co-occur with further clarifying linguistic information, such as a sentence-final wh-word WHICH (10a').

- (10) a. ?HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL?

'Will her parents buy her a car, or will she [use the money to] travel?'

- a'. HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL, WHICH?

'Will her parents buy her a car, or will she [use the money to] travel?'

- b. HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL, (DON'T-KNOW WHICH)

'Her parents will buy her a car or she will travel, I'm not sure which.'

- c. HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL, (MAYBE BOTH)

'Her parents will buy her a car or she will travel, maybe both.'

Predicates (11) and noun phrases (12) can also be coordinated with COORD-shift, although again (11a) and (12a) are reported to be not as good as if WHICH were added at the end of the question.

- (11) a. ?MARY SWIM COORD-shift RUN?
 'Does Mary swim or run?'
 b. MARY SWIM COORD-shift RUN, (DON'T-KNOW WHICH).
 'Mary swims or runs, I'm not sure which.'
 c. MARY SWIM COORD-shift RUN, (MAYBE BOTH).
 'Mary swims or runs, and maybe both.'
- (12) a. ?MARY HAVE COFFEE COORD-shift TEA?
 'Did Mary have coffee or tea?'
 b. MARY HAVE COFFEE COORD-shift TEA, (DON'T-KNOW WHICH).
 'Mary had coffee or tea, I'm not sure which.'
 c. MARY HAVE COFFEE COORD-shift TEA, (MAYBE BOTH).
 'Mary had coffee or tea, and maybe both.'

As we have seen, both COORD-shift and COORD-L pattern much like English disjunction, and yet depending on the context they can also be interpreted as conjunction. Although this seems to be rare from the point of view of English, there are some reports of other languages in which conjunction and disjunction are similarly disambiguated by context. One example is Maricopa, a Yuman language, which juxtaposes items for coordination (Gil 1991 as reported in Haspelmath 2004) similarly to COORD-shift in

ASL. In (13a) the verb is marked with the plain future tense, and it is believed with a higher certainty than the sentence in (13b), in which the verb has the additional marking of a modal/evidential element. Consequently, (13a) is interpreted conjunctively while (13b) is interpreted disjunctively, even though in both cases the NP coordinates are simply juxtaposed.

(13a) John-s Bill-s vʔaawuum.

John-NOM Bill-NOM 3.come.PL.FUT

"John and Bill will come."

(13b) John-s Bill-s vʔaawuumsaa.

John-NOM Bill-NOM 3.come.PL.FUT.INFER

"John or Bill will come."

Another example is Japanese where NPs can also be coordinated by juxtaposition, and in this case meaning also depends on the surrounding context (14a-b) or by adding 'to' (and) or 'ka' (or) (Ohori 2004).

(14a) Doko-ni ikatai no?

Where-DAT go.VOL PRT

‘Where do you wish to go?’

Kyoto, Nara, Kobe, da na

Kyoto, Nara, Kobe, COP PRT

‘Kyoto Nara, and Kobe, I suppose’

(14b) Doko-ni sumitai no?

Where-DAT live.VOL PRT

‘Where do you wish to live?’

Kyoto, Nara, Kobe, da na

Kyoto, Nara, Kobe, COP PRT

‘Kyoto Nara, or Kobe, I suppose’

Haspelmath (2004; 2007) provide an extensive typological investigation of conjunction but very little attention is given to disjunction; the pattern in ASL presented here suggests that further investigation of disjunction in ASL and other languages like Maricopa and Japanese may lead to uncovering generalizations concerning the relationship between conjunction and disjunction, and especially the ways that these logical relationships can be conveyed by juxtaposing items in a list without lexical items like 'and' or 'or'.

It's important to note that while both forms of general coordination in ASL share physical similarities with the gestures that an English speaker might use when discussing lists of items (listing items on the hand or gesturing to points in space), ASL is different in that these movements can act as part of the grammar to coordinate items on their own (without other forms of coordination). It's certainly possible that either may have originated from non-linguistic gestures of listing items in the space in front of the body (for COORD-shift) or on the fingers of the hand (for COORD-L). In spoken language, these gestures seem to be able to be used with both conjunction and disjunction, and therefore it's perhaps not surprising that they may have evolved into general use

coordinators in ASL, as opposed to strictly conjunction or disjunction. Even in ASL, it is possible to layer a different form of disjunction (such as #OR, discussed below) on top of either of the general use coordinators seen here, to clarify that the coordination should be interpreted as disjunction. However, despite all of the physical properties that they share with gestures, crucially they can also be used as linguistic elements to express coordination on their own, as shown many times in this section.

3.1.2. Uniquely Disjunction: Fingerspelling and a Historical Sign

ASL has two signs that are always interpreted as disjunction when used to coordinate items. The first, which will be labeled #OR following the convention for marking fingerspelled words in sign languages, appears to be a borrowing from English and is expressed using the ASL fingerspelling system: it consists of spelling first the letter “o” and then the letter “r”, both shown in Figure 3.3.

Figure 3.3: #OR, made up of the fingerspelling letters "o" and "r". Seen in:

<http://www.aslpro.com/cgi-bin/aslpro/aslpro.cgi>

#OR has the same distribution and interpretation as the English "or": it appears in exclusive and inclusive statements as well as alternative questions, and coordinates clauses, VPs, and NPs (15)-(17).

- (15) a. HER PARENTS WILL BUY HER CAR #OR SHE WILL TRAVEL?
 `Will her parents buy her a car, or will she [use the money to] travel?'
 b. HER PARENTS WILL BUY HER CAR #OR SHE WILL TRAVEL,
 (DON'T-KNOW WHICH)
 `Her parents will buy her a car or she will travel, I'm not sure which.'
 c. HER PARENTS WILL BUY HER CAR #OR SHE WILL TRAVEL,
 (MAYBE BOTH)
 `Her parents will buy her a car or she will travel, maybe both.'
- (16) a. MARY SWIM #OR RUN?
 `Does Mary swim or run?'
 b. MARY SWIM #OR RUN, (DON'T-KNOW WHICH).
 `Mary swims or runs, I'm not sure which.'
 c. MARY SWIM #OR RUN, (MAYBE BOTH).
 `Mary swims or runs, and maybe both.'
- (17) a. MARY HAVE COFFEE #OR TEA?
 `Did Mary have coffee or tea?'
 b. MARY HAVE COFFEE #OR TEA, (DON'T-KNOW WHICH).
 `Mary had coffee or tea, I'm not sure which.'

c. MARY HAVE COFFEE #OR TEA, (MAYBE BOTH).

'Mary had coffee or tea, and maybe both.'

During the course of consulting with native signers about disjunction, a number of signers remarked on the fact that a general use coordinator can be paired with #OR to create an unambiguous meaning of disjunction. When combined with COORD-L, #OR is signed between touching of the fingers, and when combined with COORD-shift, #OR is signed during the shift in location.

The second unambiguously disjunctive coordinator in ASL is illustrated in Figure 3.4. It is labeled "OR-Which", because it is homophonous with the wh-word that means WHICH in wh-questions such as (18).

(18) MARY DRINK WHICH?

'Which did Mary drink?'

Figure 3.4. OR-Which, from <http://www.signingsavvy.com/>

Like the fingerspelled #OR, OR-Which can be used in both inclusive and exclusive interpretations of disjunction in statements (19-21b-c), and can coordinate clauses, NPs, and VPs. Some signers report it as awkward when interpreted as disjunction in alternative questions (19a,20a,21a), although others found it to be fine in such cases.

- (19) a. %HER PARENTS WILL BUY HER CAR OR-Which SHE WILL TRAVEL?
 `Will her parents buy her a car, or will she [use the money to] travel?'
- b. HER PARENTS WILL BUY HER CAR OR-Which SHE WILL TRAVEL, (DON'T-KNOW WHICH)
 `Her parents will buy her a car or she will travel, I'm not sure which.'
- c. HER PARENTS WILL BUY HER CAR OR-Which SHE WILL TRAVEL, (MAYBE BOTH)
 `Her parents will buy her a car or she will travel, maybe both.'
- (20) a. %MARY SWIM OR-Which RUN?
 `Does Mary swim or run?'
- b. MARY SWIM OR-Which RUN, (DON'T-KNOW WHICH).
 `Mary swims or runs, I'm not sure which.'
- c. MARY SWIM OR-Which RUN, (MAYBE BOTH).
 `Mary swims or runs, and maybe both.'
- (21) a. %MARY HAVE COFFEE OR-Which TEA?
 `Did Mary have coffee or tea?'

b. MARY HAVE COFFEE OR-Which TEA, (DON'T-KNOW WHICH).

'Mary had coffee or tea, I'm not sure which.'

c. MARY HAVE COFFEE OR-Which TEA, (MAYBE BOTH).

'Mary had coffee or tea, and maybe both.'

One possible hypothesis for the marked status of OR-Which for some signers in alternative questions is that there is an interfering meaning as the wh-word WHICH, and so to avoid confusion between a wh-question (using WHICH) and an alternative question (using OR-Which), the use of this disjunction in alternative questions is avoided. It's true that this sign is extremely common when used as a wh-word in questions such as (18), and the signers consulted for this paper consider its use in statements as disjunction to be more rare. However, this cannot be the entire explanation for the ungrammaticality of the alternative question use of OR-Which, because alternative questions and wh-questions have different non-manual marking in ASL (brow raising versus brow furrowing). In other words, prosody alone should be sufficient to disambiguate these two uses, suggesting that something else beyond avoiding confusion may be involved.

OR-Which is anecdotally reported to be historically older and used less frequently among young and middle-aged signers than among older generations. This is consistent with reports from Fischer (1996) and Shaw and Delaport (2010) that the same sign occurs in the historically older language Langue des Signes Française (LSF, or "French Sign Language") with the meaning "this one or that one."³ All judgments reported here concerning the use of OR-Which were from middle-aged and younger signers who do not

³ Thanks to Peggy Lott for noticing this similarity.

themselves claim to use this sign, but only see their much older family members use it occasionally, and so it will be omitted from further investigations of interpretations of disjunction in ASL below.

3.1.3. Not Disjunction, But a Related Discourse Particle

A discussion of disjunction in ASL would not be complete without mention of another sign which I will gloss as EITHER, seen in Figure 3.5. In this sign both hands form the V handshape, making contact at the fingertips, and the dominant hand has an internal movement alternating which fingertips are touching.

Figure 3.5. EITHER ("either...or"; "one or the other"), seen in

<http://www.aslpro.com/cgi-bin/aslpro/aslpro.cgi>

In ASL/English dictionaries, EITHER can be found glossed with the English word "or" (ASLpro.com 2011). However, unlike the previous expressions of disjunction discussed above it cannot be used on its own in disjunctive statements or alternative questions, and does not conjoin clauses, NPs, or VPs (22)-(24).

- (22) a. *HER PARENTS WILL BUY HER CAR EITHER SHE WILL TRAVEL?
 `Will her parents buy her a car, or will she [use the money to] travel?'
- b. *HER PARENTS WILL BUY HER CAR EITHER SHE WILL TRAVEL, (DON'T-KNOW WHICH).
 `Her parents will buy her a car or she will travel, I'm not sure which.'
- c. *HER PARENTS WILL BUY HER CAR EITHER SHE WILL TRAVEL, (MAYBE BOTH).
 `Her parents will buy her a car or she will travel, maybe both.'
- (23) a. *MARY SWIM EITHER RUN?
 `Does Mary swim or run?'
- b. *MARY SWIM EITHER RUN, (DON'T-KNOW WHICH).
 `Mary swims or runs, I'm not sure which.'
- c. *MARY SWIM EITHER RUN, (MAYBE BOTH).
 `Mary swims or runs, and maybe both.'
- (24) a. *MARY HAVE COFFEE EITHER TEA?
 `Did Mary have coffee or tea?'
- b. *MARY HAVE COFFEE EITHER TEA, (DON'T-KNOW WHICH).
 `Mary had coffee or tea, I'm not sure which.'
- c. *MARY HAVE COFFEE EITHER TEA, (MAYBE BOTH).
 `Mary had coffee or tea, and maybe both.'

Instead, EITHER seems to occur as particle when disjunction is already present, as in (25). In this way it is similar to English "either", which cannot occur on its own, but co-occurs with "or".

- (25) HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL,
EITHER.

'Either her parents will buy her a car or she will travel.'

Also similarly to English "either", EITHER serves to disambiguate between exclusive and inclusive disjunction, because it can never appear in inclusive disjunctive statements (26).

- (26) #HER PARENTS WILL BUY HER CAR COORD-shift SHE WILL TRAVEL,
MAYBE BOTH, EITHER.

#'Either her parents will buy her a car or she will travel, maybe both.'

Thus, while it is technically not a form of disjunction in ASL, EITHER serves an important role of disambiguating between inclusive and exclusive interpretations of disjunction, and also, crucially, between disjunctive and conjunctive interpretations of general use coordinators. A summary of this and other forms investigated in this section can be found in Table 3.1.

Table 3.1: The use of five disjunctive expressions in ASL in alternative questions, exclusive statements, and inclusive statements.

	Alternative Questions: "MARY HAS COFFEE OR TEA?"	Exclusive Statements: "MARY HAS COFFEE OR TEA" (DON'T-KNOW WHICH)	Inclusive Statements: "MARY HAS COFFEE OR TEA" (MAYBE BOTH)
COORD-shift	OK (preferred together with WHICH)	YES	YES
COORD-L	YES (for some, dispreferred with light NPs)	YES (for some, dispreferred with light NPs)	YES (for some, dispreferred with light NPs)
EITHER	Only when disjunction is already present	Only when disjunction is already present	NO
#OR	YES	YES	YES
OR-Which	Antiquated and marginal/dispreferred	Antiquated but OK	Antiquated but OK

3.1.4. Contextual Effects on the Interpretation of ASL Disjunction

We saw above that COORD-shift, COORD-L, and #OR can all be interpreted both exclusively and inclusively⁴. In other words, for each of the possible instantiations of disjunction in ASL, the disjunctive phrase can be followed by DON'T-KNOW WHICH (triggering the exclusive reading) or MAYBE BOTH (triggering the inclusive reading). In this section, I discuss which of these interpretations the disjunctive phrase receives when it isn't followed by these disambiguating phrases, but must be inferred

⁴ In what follows I omit discussion of OR-Which because consultants considered it antiquated and consequently expressed uncertainty about their judgments. When asked to make a guess, they thought it patterns like COORD-L and #OR.

from the context. This is important not only for better understanding of the semantics of these logical connectives, but also for the pragmatics experiment in section 3.2.

Recall that in English, disjunctive phrases using "or" are usually interpreted with an *exclusive* reading: "She drank tea or coffee" typically means she had tea, or coffee, **but not both**. However, certain environments favor the inclusive reading, such as the antecedent of a conditional (27) or a noun phrase headed by a universal quantifier (28), both of which were used above in (2). In these environments, "tea or coffee" can easily mean tea, coffee or **both**.

(27) If Mary drank tea or coffee, she'll feel sick.

→ Mary will feel sick if she drank tea, coffee, or both.

(28) All of the girls who drank tea or coffee felt sick.

→ All of the girls who drank tea, coffee, or both, felt sick.

In ASL, disjunction is also affected by these environments. By default, MARY DRANK TEA {COORD-L/COORD-shift/#OR} COFFEE implies that Mary drank tea or coffee but not both, while for disjunctive phrases containing COORD-L and #OR the inclusive reading is most prominent in the antecedent of a conditional (29) or in a noun phrase headed by a universal quantifier (30), just like in English.

(29) IF MARY DRINK TEA COORD-L /#OR COFFEE, WILL FEEL SICK.

“If Mary drank tea or coffee, she'll feel sick”

→ Mary will feel sick if she drank tea, coffee, or both.

(30) ALL GIRL DRINK TEA COORD-L /#OR COFFEE FEEL SICK.

“All of the girls who drank tea or coffee felt sick.”

→ All of the girls who drank tea, coffee, or both felt sick.

One surprising difference is COORD-shift behaves somewhat differently from the other forms of disjunction in ASL and in English: it is reported to be awkward grammatically in exactly the environments which usually favor the inclusive reading (31)-(32).

(31) ?IF MARY DRINK TEA COORD-shift COFFEE, WILL FEEL SICK.

(“If Mary drank tea or coffee, she’ll feel sick”)

(32) ?ALL GIRL DRINK TEA COORD-shift COFFEE FEEL SICK.

(“All of the girls who drank tea or coffee felt sick.”)

These sentences are fine in ASL when they have a different meaning: when COORD-shift is interpreted as conjunction (33)-(34).

(33) IF MARY DRINK TEA COORD-shift COFFEE, WILL FEEL SICK.

“If Mary drank tea and coffee, she’ll feel sick”

(34) ALL GIRL DRINK TEA COORD-shift COFFEE FEEL SICK.

“All of the girls who drank tea and coffee felt sick.”

In other words, in the same environments in which English "or" and other forms of disjunction in ASL and other languages receive an inclusive interpretation, COORD-shift

is interpreted as conjunction, instead. Recall that this cannot be due to a lack of availability for the inclusive interpretation in general for COORD-shift: as we saw in (10)-(12)c, and summarized in Table 1, it's certainly possible to interpret COORD-shift as an inclusive disjunction. Instead, it seems that COORD-shift is unable to receive a disjunctive interpretation at all in these contexts.

Understanding this pattern may require further study beyond the scope of this paper, but one possible explanation for (31)-(34) is that the nonmanual marking required for the disjunctive reading of COORD-shift is not available within the nonmanual marking required for the surrounding environments. Semantically, both of these environments (the antecedent of a conditional and the relative clause in a noun phrase headed by a universal quantifier) share the property of being downward-entailing, which while crucial to understanding and calculating the meaning, is not unique about ASL. What is unique about these environments in ASL is that both of these environments have obligatory nonmanual marking in addition to the manual signs (raising of the eyebrows, among other factors). This requirement may conflict with the obligatory nonmanual marking (similar in form to that seen in the larger environment) on COORD-shift when it is interpreted as disjunction that is absent when it is interpreted as conjunction. Thus, part of the reason that COORD-shift is interpreted as conjunction in (33)-(34) could be that the brow raising nonmanual marking is attributed to the larger structure (the conditional or the relative clause) and not to the COORD-shift, leading to a conjunctive (not disjunctive) interpretation. One test for this hypothesis would be to find a context in which disjunction is typically interpreted as inclusive in English (i.e. which is downward

entailing), but which does not have obligatory brow raise (or any other) nonmanual marking in ASL. The existence of such an environment is currently an open question.

3.2. Quantitative Investigation of General Use Coordination Scale

We have seen that for the most part, general use coordinators in ASL share the same distributional properties as their English counterparts when they appear as disjunction, and yet in the case of the two general use coordinators COORD-shift and COORD-L they do not contrast lexically with conjunction. This leads to an intriguing possibility of testing the importance of lexical contrast between scalar items for the calculation of scalar implicatures.

In English, the items that make up the scale <and, or> contrast in meaning and in their phonological shape. On the other hand, as we just saw, the same phonological shape conveys both meanings in ASL. Making use of this unique property of ASL, this section presents data from an experiment involving native signers of ASL and native speakers of English using a Felicity Judgment Task. Included is a comparison of the coordination scale in ASL with the coordination scale in English, as well as a comparison of the coordination scale in ASL with a more prototypical scale in ASL (quantifiers). There are many examples in the literature testing scalar implicature calculation in languages other than English (Noveck 2001; Papafragou and Musolino 2003; Slabakova 2010, among others) and all find similar behavioral results in their participants with prototypical scales. So, we can expect that where ASL makes a similar lexical distinction to English, as in its quantifier scale (<ALL, SOME>), there should be a similar rate of scalar implicature calculation.

However, to my knowledge no previous work directly compares one language to another which makes a different lexical distinction of the scalar items, and this is the first experiment testing a language that completely lacks a lexical distinction between potential scalar items. If calculation by deaf native signers on the coordination scale in ASL looks just like other scales in ASL, and like the coordination scale in English, then we can conclude that lexical contrast is not an important feature of a semantic scale. On the other hand, if there is less scalar implicature calculation on the coordination scale in ASL than other scales in ASL, or than the coordination scale in English, this would suggest that lexical contrast is an important part of scalar implicature calculation. The experiment below tests these predictions, and finds that in fact there is less scalar implicature calculation based on coordination in ASL. I end with suggestions for including lexicalized contrast as a component of scalar implicature calculation, and how this fit into current theories of scalar implicature.

Methods

Participants were 22 adults from the greater San Diego area. Ten were adults who self-identify as deaf and have been learning and using American Sign Language from birth because they had at least one deaf parent. All were deaf to the extent that they were unable to hear normal speech, and all used ASL in their home, at work, or both. These participants were recruited directly through email requests from a laboratory database of interested participants or indirectly through recommendations by friends. All received reimbursement in cash or gift cards. I will refer to these ten participants as "native signers of ASL". The twelve remaining participants were typically hearing undergraduate

students at the University of California who are native speakers of English and have had no exposure to ASL. These participants received course credit for participating in the experiment. I will refer to these participants as "native speakers of English".

Procedures and Stimuli

Each testing session lasted 30-35 minutes. The participant sat in front of a 13 inch Macbook laptop on a table, either at UCSD or, for some native signers of ASL, at various meeting places throughout San Diego county. Both the instructions and the task itself were presented on the laptop in video form, by a native signer of ASL (ASL version) or a native speaker of English (English version). Participants were instructed that for each trial of the experiment, a picture will appear on the screen, and that after looking at the picture, they should press the Space Bar key and a video description will begin to play next to the picture. Participants were told to press the smile face (the "1" key covered with a smile face sticker, directly below the picture of a smiling face on screen) if they were "satisfied that the description matches the picture." If they were "not satisfied, and think that the description does not match the picture", they were instructed to press the frown face (the "0" key covered with a frown face sticker, directly below the picture of the frowning face on screen) (Figure 3.6). It was impossible in both the ASL version and in the English version to replay a video.

Figure 3.6: Screenshot during an ASL quantifier experimental trial. The picture is always on the left, and the signed description of the picture appears on the right after the Spacebar key is pressed.

Participants saw three practice trials to acquaint them with the task: (1) a picture of a red bowl, and a video description (ASL: THAT BOWL, RED; English: "The bowl is red"); (2) a picture of a white shoe, and a video description (ASL: THAT SHOE, BLACK; English: "The shoe is black"); (3) a picture of a wooden spoon, and a video description (ASL: THAT SPOON, WOODEN; English: "The spoon is wooden"). Practice trials were followed by further instructions, and a confirmation that the task was understood. Finally, 48 experimental trials were presented. Of these, 24 were fillers used as experimental conditions for other studies, and 24 were experimental conditions in the current study. The current experiments' 24 trials consisted of 12 trials of each sentence type: (a) Quantifiers, which are a prototypical scale in ASL and in English and (b) Coordination, which has a lexical contrast in ASL but not in English. Responses were recorded using Psyscope experimental software.

(a) Quantifiers.

The quantifier scale was used as the baseline case for scalar implicature calculation in this experiment for ASL, both compared to the coordination scale in ASL and compared to the quantifier scale in English. As in coordination, ASL has multiple signs which can be translated into English as "some" or "all". In this experiment, the version of the quantifiers SOME and ALL that are shown in Figure 3.7 were used. These quantifiers can serve as a prototypical scale in ASL because they contrast lexically in the same way in ASL as they do in English. Based on all previous research on these types of scales in other languages (Papafragou & Musolino 2003) and in ASL (Davidson, Chapter 2, this dissertation), they were expected to pattern like their English counterparts.

Figure 3.7. SOME and ALL used in the Quantifier sentence type.

In Quantifier trials, each picture consisted of a set of three objects of which either some of the objects or all of them fulfilled a characterization about that object (e.g. red cans, lit candles, full glasses, etc.) A schema is shown in Figure 3.9, and the entire list can be found in Appendix 1 (English) or Appendix 2 (ASL). Under the **Match** condition, the

characterization applied to all of the objects (e.g. three cans, all red), and the description was accurate (e.g. CANS, ALL RED "All of the cans are red."). Under the **Mismatch** condition, the characterization applied to only two of the objects (e.g. three cans, only two are red), and the description was not accurate (e.g. CANS, ALL RED "All of the cans are red."). Finally, under the **Test** condition, the characterization applied to all of the objects (e.g. three cans, all red), and the description was not maximally informative (e.g. CANS, SOME RED "Some of the cans are red."). In this way, the weak scalar term **SOME** was only evaluated by participants in the Test condition, so that they were never directly comparing this condition to use of the term when it was maximally informative. Trials for all sentence types were counterbalanced so that each sentence frame (e.g. red cans) appeared in only one trial type (Match, Test, Mismatch) for each participant, and each third of participants saw the sentence frame in a different trial type.

(b) Coordination

As shown above, coordination in ASL is a complex topic. There are multiple ways to test the pragmatic interpretation of conjunction or disjunction in ASL, but the main issue in this section is whether a general use coordinator has the same pragmatic interpretation (i.e. a scalar implicature interpretation) as the lexically contrastive "and" and "or" in English. As shown in section 3.1, there are two types of general use coordinators to choose from: COORD-shift and COORD-L. In this experiment, the sentences are very simple, and COORD-L was reported to have prosodic restrictions when connecting prosodically light nouns. Although COORD-shift is sometimes felt to be odd in alternative questions, in this experiment each trial was always a declarative

sentence (the test was whether it was interpreted as exclusive or inclusive disjunction). In section 3.1.4 we also saw that COORD-shift(or) does not receive a disjunctive interpretation in downward entailing environments such as the antecedent of conditionals, but none of this type of environment was used in this experiment: each trial was a simple un-embedded sentence. Therefore, COORD-shift was used as the general use coordinator. When interpreted as disjunction, there was additional brow-raising nonmanual marking on the disjuncts (see Figure 3.8) and I labeled this use of the coordinator COORD-shift(or). The other use, without brow-raising and conveying conjunctive meaning, was labeled COORD-shift(and).

COORD-shift(and)

Figure 3.8: COORD-shift(and) and COORD-shift(or) used in the Coordination sentence type. Figure continued on next page.

COORD-shift(or)

Figure 3.8 continued

In each of the Coordination trials, the picture consisted of two different objects (e.g. a mug and a bowl), and then either one or two of the same type of object (e.g. spoons) in relation to the first objects. Again, the schema can be seen in Figure 3.9, and the full list can be found in the Appendices. In the **Match** condition in these trials, each of the two different objects were related to one of the similar objects, and the description was accurate (e.g. HAVE SPOON IN CUP COORD-shift(and) SPOON IN BOWL. "A spoon is in the mug and a spoon is in the bowl."). Under the **Mismatch** condition, only one of the two different objects were related to one of the similar objects, but the description said that they both were equally related (e.g. HAVE SPOON IN CUP COORD-shift(and) SPOON IN BOWL. "A spoon is in the mug and a spoon is in the bowl."). Finally, under the **Test** condition, each of the two different objects were related to one of the similar objects, but the description was not maximally informative due to the disjunctive nonmanual marking on the general use coordinator (e.g. HAVE SPOON

IN CUP COORD-shift(or) SPOON IN BOWL "A spoon is in the mug or a spoon is in the bowl").

Figure 3.9. Design of 24 experimental trials, shown in English: 12 Quantifier trials, 12 Coordination trials.

Results

Native speakers of English showed no significant difference in their acceptance of an underinformative description in the two prototypical Horn scales in English: the quantifier scale and the coordination scale (in fact, the mean accuracy rate for each scale, which for the Test cases was rate of rejection, was each 0.77, with a standard deviation of 0.36 for coordination and 0.38 for quantifiers, shown in Table 3.2). Both were also accepted (i.e. indicated with a smile face) significantly less often than the control Match sentence in each sentence type ($t(11)=7.10$, $p<0.0001$ for quantifiers; $t(11)=6.76$, $p<0.0001$ for coordination), although according to the pre-strengthened reading both the Test and the Match conditions are technically true. This indicates that scalar implicature calculation was occurring for both scales in English, at the same rate, which is what we would expect from previous literature on these scales in English.

Table 3.2: Mean rejection rates (with standard deviations) for Quantifiers and Coordination in English and in ASL

		Match	Mismatch	Test
English	Quantifiers	0	1	0.77 (0.38)
	Coordination	0.02 (0.07)	0.92 (0.16)	0.77 (0.36)
ASL	Quantifiers	0.05 (0.16)	0.98 (0.08)	0.90 (0.13)
	Coordination	0.20 (0.20)	0.83 (0.17)	0.35 (0.21)

Native signers of ASL also accepted the Test condition of the prototypical quantifier scale in ASL significantly less often than the Match condition of the quantifier

scale ($t(9)=15.38$, $p<0.0001$), although again with the weak reading they are both true. This indicates that scalar implicatures were being calculated for the Test condition, as expected because they were based on a prototypical scale. Moreover, they behaved just like their English counterparts: there was no significant difference on scalar implicature calculation in the quantifier scale between native signers of ASL and native speakers of English ($t(20)=1.03$, $p>0.1$). This indicates a typical rate of scalar implicature calculation by this group of signers on a prototypical scale in ASL, confirming the results found from a separate group of signers on the same quantifier scale in ASL (Davidson, Chapter 2, this dissertation). In sum, when both languages have a prototypical scale, native users of the languages accept under-informative test trials to the same extent.

However, coordination in ASL shows a different pattern: native signers show significantly less calculation of scalar implicatures based the disjunction/conjunction scale in ASL compared to native speakers on the coordination scale in English ($t(20)=3.25$, $p<0.01$)(Figure 3.10). In section 3.1, ASL coordinators were shown to pattern like English coordinators syntactically and semantically; here we find that despite these similarities, there is a significant difference in pragmatic interpretation. Since there was no difference between the acceptance of the quantifier scales in both languages, we cannot attribute this to a general behavioral difference in the populations of native ASL signers and native English speakers.

Figure 3.10: Calculation of implicatures (i.e. rejection rates) on quantifier and coordinator scales in ASL and English

Furthermore, within ASL there was significantly less scalar implicature calculation on the disjunction/conjunction scale than on the quantifier scale ($t(9)=7.57$, $p<0.0001$), seen in Figure 3.10. These results are striking, considering that they are both responses to the same trial type (the underinformative Test conditions) by the same set of native signers; nonetheless, there were more rejections (i.e. pragmatic strengthening) in the quantifier sentence type than the coordination sentence type. Together with the difference seen between ASL and English on the coordination scale in the two languages, this supports the view that the instantiation of scale members as separate lexical items is important for a high rate of scalar implicature calculation.

Recall that the general use coordinator is ambiguous: depending on the surrounding context and nonmanual marking, it can be interpreted as either disjunction or conjunction. So, one explanation of the Test data presented so far could be that signers chose to interpret the coordinator in the most charitable way: they were accepting the Match sentences, but also the Test sentences, which had disjunctive nonmanual marking but which under a coordination interpretation would be felicitous. Here we can turn to the Mismatch data, where under a charitable interpretation the participants would be expected to accept the descriptions. Instead, what we find is that participants overwhelmingly reject the descriptions in the coordination Mismatch case ($M=0.83$, $SD=0.17$), which is not significantly different from the percent of accepted trials in the Match case ($M=0.80$, $SD=0.20$) ($t(9)=0.29$, $p>0.1$), but is significantly different from rejections in the Test case ($M=0.35$, $SD=0.21$) ($t(9)=5.02$, $t<0.001$). We can conclude that while participants are not likely to reject Test trial descriptions, this is specific to underinformative descriptions not triggering a scalar implicature, and not due to an overall charitable answering strategy for coordination in ASL.

3.3. Discussion and Conclusion

This investigation began by asking how ASL conveys the concepts of conjunction and disjunction as a first attempt at formalizing the study of coordination in a sign language. Traditional methods of meeting with an ASL consultant to discuss methods of coordination in ASL, with verification from other native signers, yielded a multi-faceted picture. Disjunction is conveyed in ASL in four different ways: one sign is a borrowing from English through the fingerspelling system (#OR), one is an antiquated sign related

to disjunction in French Sign Language (OR-Which), and two are general use coordinators (COORD-shift and COORD-L) which are non-specific towards a conjunctive or disjunctive interpretation. For these general use coordinators, meaning is determined by the context and other linguistic information such as prosodic marking and the addition of disambiguating lexical material. I showed that these general use coordinators and also both specific types of disjunction can all be used to coordinate phrases at multiple levels (IP, VP, NP) and for various semantic types of disjunction (both exclusive and inclusive, in both interrogative and declarative clauses), similarly to English "or". These contrast with another sign frequently cited in ASL dictionaries as "or" which I show actually behaves similarly to English "either". The overall picture that arises is one which allows for multiple strategies and the layering of a specific coordinator concurrent with a general one.

The existence of general use coordination in ASL also provides an intriguing test case for better understanding scalar implicatures. Since Gazdar (1979) and Horn (1989), most analyses of scalar implicatures have been based on the hypothesis that the lexical items <and, or> form a scale where use of the weaker term "or" triggers the implicature that the stronger term "and" is false. Despite the widespread use of these "Horn scales" in the theory of meaning of these basic terms, it was still unclear how important the lexical form of the words are as there is no mention of the role of lexical contrast. However, in a more automatic lexically based theory (Levinson 2000) or grammatical theory (Chierchia et al. to appear) of scalar implicatures, the triggering of the implicature is based on a conventionalized pairing of scalar lexical items, which indirectly suggests that two separate words should be linked, not two versions of the same lexical item. In ASL,

disjunction and conjunction contrast in the semantics (i.e. there is a way to differentiate these meanings via nonmanual marking) but not in the lexicon, so it's possible to test the role of the lexical contrast in these pragmatic inferences.

Behavioral data collected from a quantitative study of native signers showed that there is significantly less calculation of scalar implicatures based on general use coordinators in ASL compared to implicatures based on lexically contrastive scales in ASL. Moreover, there is significantly less calculation of scalar implicatures based on these coordinators in ASL compared to the <and, or> coordination scale in English, shown by behavioral data from native speakers of English using exactly the same experimental design. In English, "and" and "or" have the same syntactic and semantic properties as disjunction and conjunction in ASL, but unlike in ASL, the English items are instantiated with separate overt lexical items. Combined, these results support the view that the instantiation of scale members as separate lexical items is important for the robust occurrence of scalar implicatures, and that contrasting semantics is not enough.

Despite the large amount of ink spilled to better understand scalar implicature calculation, there has been surprisingly little experimentation done to determine what properties a scale must have. Recent studies have compared implicatures based on Horn scales like <all, some> to those based on ad hoc scales specific to a context, but such "scales" differ in two respects: unlike the ad hoc scale, the quantifier scale is based on alternatives which are their own lexical items, but also unlike the ad hoc scale, the quantifier scale is based on a conventionalized set of meanings which are always alternatives to each other. In the case of disjunction and conjunction in ASL, the scale is not based on alternatives which are their own lexical items, although they carry the same

meaning as they do in English and so form a contrastive meaning set. The fact that there is a difference in scalar implicature calculation for the ASL coordination scale compared to the English, when there is no difference in scalar implicature calculation for the quantifier scale between the two languages, shows that the form of the scalemates is indeed an important part of the scalar implicature. Theories must not only suggest that the form of alternatives should be all the same prosodically (Matsumoto 1995) or syntactically (Katzir 2007), but have a lexical contrast as well.

Clearly, coordination (both disjunction and conjunction) in ASL is a surprisingly understudied area, and one which hopefully can build in the future on the material presented here. For example, during the data collection some signers suggested that there may be a morphological marker which disambiguates conjunction and disjunction in the case of COORD-L lists: larger, more deliberate internal movement may indicate conjunction, while smaller repeated internal movements may indicate disjunction. This and other investigations of prosody and morphology are left to future research. Also, in syntax further investigation involving island constraints would be of significant interest, as would further possibilities for non-manual marking of coordinators.

Beyond the specific data that the current work brings to the study of scalar implicatures, my hope is that this work can also play a role in encouraging data from languages outside of the most well-studied spoken European languages in implicature studies. It is true that the social nature of pragmatics might dissuade researchers from drawing general conclusions about phenomena like implicatures from less studied languages that occur in different cultural setting, but here I show that by studying coordination along with a comparable quantifier scale in ASL, it is possible to set a

baseline for expectation of implicature calculations and then draw conclusions based on these results. Sign languages in particular are fertile ground because they so frequently exist within the cultural context of another spoken/written language, also creating opportunities for studies of bilingual implicature calculation among hearing signing populations. Finally, in the process of arriving at a better understanding of semantic pragmatic phenomena generally, we can also learn about the interface of semantics/pragmatics specifically in a sign language, which is a field still in its infancy.

Acknowledgements

Much gratitude to Marla Hatrak, Ivano Caponigro, Rachel Mayberry, Carol Padden, Brandon Scates, Peggy Lott, Cami Miner, Corinne Brion, Philippe Schlenker, members of the UCSD Sign Language Reading Group, Multimodal Language Development lab, and Semantics Babble. This chapter, in full, is currently being prepared for submission for publication of all of the material presented here. [Davidson, Kathryn]. The dissertation author was the primary investigator and author of this material.

Appendix 1: Stimuli for the English version of the experiment

Quantifiers

All/Some of the balls are yellow.

All/Some of the books are open.

All/Some of the candles are lit.

All/Some of the cans are red.

All/Some of the pencils are broken.

All/Some of the bowls are yellow.

All/Some of the cards are black.

All/Some of the glasses are full.

All/Some of the hangers are brown.

All/Some of the shoes are black.

All/Some of the socks are brown.

All/Some of the spoons are wooden.

Coordination

A ball is in front of the globe and/or a ball is in front of the shoe.

A bear is in the glass and/or a bear is in the bowl.

A cereal box is in the box and/or a cereal box is in the purse.

A marker is on the wallet and/or a marker is on the oven mitt.

A pencil is in front of the cereal box and/or a pencil is in front of the can of juice.

A plate is under the white candle and/or a plate is under the brown candle.

A ruler is in the black cup and/or a ruler is in the glass.

Scissors are on the book and/or scissors are on the shoe.

A sock is in the blue shoe and/or a sock is in the brown shoe.

A spoon is in the mug and/or a spoon is in the bowl.

A toothbrush is in the mug and/or a toothbrush is in the bottle.

A towel is on the pineapple and/or a towel is on the book.

Appendix 2: Stimuli for the ASL version of the experiment

Quantifiers

N.B.: The first noun is topicalized with brow raising nonmanual marking.

BALL, ALL/SOME YELLOW.

BOOKS, ALL/SOME OPEN.

CANDLE, ALL/SOME LIT.

CAN, ALL/SOME RED.

PENCIL, ALL/SOME BROKE.

BOWL, ALL/SOME YELLOW.

(Playing)CARD, ALL/SOME BLACK.

CUP, ALL/SOME FULL.

HANGER, ALL/SOME BROWN.

SHOE, ALL/SOME BLACK.

SOCK, ALL/SOME BROWN.

SPOON, ALL/SOME WOODEN.

Coordination

N.B.: Many clauses involve spatial classifiers. These are notated using the conventions in Sandler & Lillo-Martin (2006), where CL marks the existence of a classifier, what follows is the handshape of the classifier (e.g. "B", "5(claw)", etc., determined by the size and shape of the noun) and finally the location in space where the classifier is signed, notated with subscripts X, Y, or Z.

HAVE BEAR CL:V(curved)_X(inside cupped nondominant hand) WINE CL:C_X COORD-

shift(and/or) BOWL_Y CL:V(curved)_Y(inside cupped nondominant hand).

HAVE TOOTHBRUSH CL:G_X(inside cupped nondominant hand) MUG COORD-shift(and/or)

BOTTLE CL:G_X(inside cupped nondominant hand).

HAVE PLATE CL:C(reduced)_X CL:C(reduced)_Y [WHITE CANDLE CL:C_X(nondominant hand

flat) COORD-shift(and/or) BROWN CANDLE CL:C_Y(nondominant hand flat)]

HAVE COLOR MARKER [WALLET CL:B_X CL:G_X COORD-shift(and/or) GLOVE

CL:B_Y CL:G_Y]

HAVE PENCIL CL:G_X CEREAL #BOX CL:B(curved)_X COORD-shift(and/or) PENCIL

CL:G_Y #JUICE CL:C_Y

HAVE BOX_X PURSE_Y CEREAL #BOX CL:B_X(inside C shaped nondominant hand) COORD-

shift(and/or) CEREAL #BOX CL:B_Y(inside C shaped nondominant hand)

HAVE MEASURE [CL:G]_X [CL:U_X(inside C shaped nondominant hand) BLACK CUP_X COORD-

shift(and/or) GLASS [CL:G]_Y [CL:U_Y(inside C shaped nondominant hand)]

HAVE SCISSORS CL:3_X(on B shaped nondominant hand) BOOK COORD-shift(and/or) SHOE

CL:3_Y(on B shaped nondominant hand)

HAVE SOCK IN BLUE SHOE COORD-shift(and/or) SOCK IN BROWN SHOE.

HAVE BALL CL:5(claw)_X GLOBE CL:5(claw)_{Y(behind X)} COORD-shift(and/or)

SANDAL CL:B_W CL:5(claw)_X.

HAVE SPOON IN CUP COORD-shift(and/or) SPOON IN BOWL.

HAVE #TOWEL PINEAPPLE CL:C(claw)_X CL:B_{X(on top)} COORD-shift(and/or) BOOK

CL:B_Y CL:B_{Y(on top)}

References

- Anderson, D. & J. Reilly. (1998). "The Puzzle of Negation: How Children Move from Communicative to Grammatical Negation in ASL," *Applied Psycholinguistics* 18, 411-429.
- ASLpro.com. (2011) Video Dictionary. <http://www.aslpro.com/cgi-bin/aslpro/aslpro.cgi>
- Baker, C. & C. Padden. (1978). "Focusing on the nonmanual components of American Sign Language." In P. Siple (ed.), *Understanding Language through Sign Language Research*. New York: Academic Press, 27-57.
- Chierchia, G. Fox, D. & B. Spector (to appear) "The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics." in Portner, P., Maienborn, C. & K. von Stechow (eds.), *An International Handbook of Natural Language Meaning*, Mouton de Gruyter.
- Davidson, K. (Chapter 2, this dissertation). "Scalar Implicatures in a Signed Language."
- Fischer, S. (1996). "By the Numbers: Language-Internal Evidence for Creolization." in W. Edmondson and R. Wilbur (eds.), *International Review of Sign Linguistics* 1. 1-22.
- Gazdar, G. (1979). *Pragmatics: Implicature, presupposition, and logical form*. New York: Academic.
- Gil, D. (1991). "Aristotle goes to Arizona and finds a language without 'And'." in Zaefferer, D. (ed.) *Semantic Universals and Universal Semantics*. Walter de Gruyter. 96-130.
- Grice, H. (1967; revised and published 1989). *Studies in the Way of Words*. Harvard University Press, Cambridge, MA.
- Haspelmath, M. (2004). editor. *Coordinating Constructions*. Philadelphia; J. Benjamins publishing.
- Haspelmath, M. (2007). "Coordination" In T. Shopen, (ed.) *Language typology and syntactic description, vol. II: Complex constructions*. 2nd ed. Cambridge: Cambridge University Press, 1-51.
- Horn, L. (1989). *A Natural History of Negation*. Chicago: Chicago University Press.
- Katzir, R. (2007). "Structurally-Defined Alternatives." *Linguistics and Philosophy* 30 (6), 669-690.

- Levinson, S. (2000). *Presumptive Meanings: the theory of generalized conversational implicature*. MIT Press: Cambridge.
- Liddell, S. (2003). *Grammar, gesture, and meaning in American Sign Language*. University Press: Cambridge
- Matsumoto, Y. (1995). "The conversational condition on Horn Scales." *Linguistics and Philosophy* 18(1), 21-60.
- Noveck, I. (2001). "When children are more logical than adults: experimental investigations of scalar implicature." *Cognition* 78(2) 165-188.
- Ohori, T. (2004). "Coordination in Mentalese." In M. Haspelmath (ed.) *Coordinating Constructions*. Amsterdam: John Benjamins Publishing Company, 41-66.
- Papafragou, A. & J. Musolino (2003). "Scalar Implicatures: experiments at the semantics-pragmatics interface." *Cognition* 86(3). 253-282.
- Reilly, J., McIntire, M. & U. Bellugi (1990). "Conditionals in American Sign Language: Grammaticized facial expressions." *Applied Psycholinguistics* 11 (4). 369-392.
- Sandler, W. & D. Lillo-Martin (2006). *Sign Language and Linguistic Universals*. Cambridge: Cambridge University Press.
- Shaw, E., & Y. Delaport. (2010) "New Perspectives on the History of American Sign Language" *Sign Language Studies* 11(2), 158-204.
- Siegal, M., Matsuo, A. & C. Pond (2007). "Bilingualism and cognitive development: Evidence from scalar implicatures." In: Y. Otsu, Editor, *Proceedings of the Eighth Tokyo Conference on Psycholinguistics*, Hituzi Syobo, Tokyo (2007), pp. 265–280.
- Signing Savy: Your Language Resource (2011). <http://www.signingsavvy.com/>
- Slabakova, R. (2010). "Scalar implicatures in second language acquisition." *Lingua* 120(10). 2444-2462.
- Sperber, D. & D. Wilson. (2008). "Relevance Theory," in L. Horn and G. Ward, Editors, *The Handbook of Pragmatics*.
- Wilbur R. & C. Patschke (1999). "Syntactic correlates of brow raise in ASL," *Sign Language & Linguistics* 2. 3-40.

CHAPTER 4

Age of Language Acquisition Effects on Scalar Implicature Calculation

Abstract

This study concerns the calculation of scalar implicatures, the inference most people make when they hear "Some teas contain caffeine" that it is also the case that "Not all teas contain caffeine." Preschool-aged children will accept statements like "Some animals got a snack" in situations where all animals do, while adults will reject them (Noveck 2001) which has been attributed to children not knowing appropriate alternatives (Barner et al. 2010), being more pragmatically tolerant (Katsos & Bishop 2011), or having processing difficulties (Chierchia et al. 2001). These hypotheses are difficult to resolve because children have less language experience than adults and also lack the social/cognitive maturity of adults. In this experiment we tested scalar implicatures on deaf adult signers who learned ASL at various ages ranging from birth to 18. Because many of these signers did not learn their first language from birth in a native-like fashion, this allows for a dissociation between language experience and life experience (Siegel & Surian 2004). Results indicate an effect of age of acquisition for the prototypical scale of quantifiers, suggesting that there is a component of language-specific knowledge that is advantageous to learn early. In contrast, on coordination and spatial ad hoc scales in which there were no contrasting lexical items in ASL, there were also no age of acquisition effects. We conclude that the organization of contrasting lexical items is not only crucial to scalar implicatures, but is something which is advantageously learned early in life.

Scalar implicature is the name given to the inference in (1b) that most adults make when they hear (1a).

- (1) a. Some teas contain caffeine.
- b. Not all teas contain caffeine.

Although (1b) follows naturally from (1a), this is an extra pragmatic inference: "some" doesn't necessarily exclude "all" in the same way that "some" indicates that "none" is false. This point is illustrated in (2a) and (2b), where it's possible to add further clarification to a sentence with "some" to indicate that "all" is true (2a), while trying to do the same for "none" leads in (2b) to an absurd statement (notated with #).

- (2) a. Some teas contain caffeine- in fact, all do!
- b. #Some teas contain caffeine- in fact, none do!

Scalar implicatures have played an important role in the study of the relationship between semantics and pragmatics because for adults they are largely automatic inferences (Noveck & Posada 2003), but are also cancelable (as in (2)) and vary in their strength depending on the context. In particular, there has been a great deal of research focused on how much of the generation of the implicature is part of the grammar, and how much is part of extra-linguistic reasoning about the way that language is used (Levinson 2000; van Rooij & Schulz 2004; Russell 2006; Chierchia et al. to appear).

Children famously fail to draw scalar implicatures (Noveck 2001; Chierchia et al. to appear) although it is still unclear whether this is due to their decreased experience with the language, or to decreased cognitive maturity and life experience. In this paper, we investigate scalar implicature calculation by adults who have decreased overall language experience relative to life experience in order to dissociate these factors. Results show that late learners sometimes calculate less implicatures than early learners, but only when the implicature is based on a scale with learned, lexicalized scalemates; other scales not based on a lexical contrast show no difference between the two groups. Since non-lexically-contrastive scales have also been shown to trigger less implicatures than typical lexically-contrastive scales, by native signers, this lends further support to the hypothesis that lexical contrast is an important component driving typical scalar implicature calculation (Davidson, Ch. 3, this dissertation).

Traditionally, scalar implicatures have been accounted for under a pragmatic theory that originated with Grice (1967; 1989) and was further developed by Horn (1989) among others. In this "Gricean" theory, the word "some" has a basic meaning compatible with "all", equivalent to "some and maybe all". However, most participants in a conversation will reason that if someone utters (1a), they could have just as easily said "All teas contain caffeine", and if that were true, it would have been a better description of the facts. Usually people in a conversation try to be as informative as possible while still being truthful, so the speaker should have said "All teas contain caffeine" if they thought that they could do so and still be telling the truth. Since the speaker didn't say that, the receiver concludes (1b), that not all teas contain caffeine. This same type of

reasoning works for other "scales" in addition to <all, some>, such as <and, or> (3), <must, may> (4), <hot, warm> (5), etc.

- (3) a. The child drank green **or** black tea.
b. It's **not** the case that the child drank green **and** black tea.
- (4) a. The child **may** drink a black tea.
b. It's **not** the case that the child **must** drink a black tea.
- (5) a. The tea is **warm**.
b. The tea is **not hot**.

As illustrated by (3)-(5), the phenomenon of a scalar implicature is not specific to the domain of quantifiers, but of any two terms that can be put in an ordering where one is strictly stronger than another.

There has been a large body of research investigating first language (L1) acquisition of scalar implicatures because children typically do not behave in an adult-like manner when it comes to drawing these inferences: in particular, children seem to compute less scalar implicatures than adults. This is shown in behavioral tasks, where four-year-olds accept sentences like "Some of the pandas got snacks" in situations where all got snacks, while adults and older children will typically reject that description as false or underinformative (Noveck 2001; Chierchia et al. 2001; Gualmini, et al. 2001; Huang & Snedeker 2009, among others). There is some variation in scales: <all, some>, <and, or>, and <must, may> follow similar patterns, while numerals do not- children don't seem to have any problem rejecting "two" as a description of a set that could also

be described with "two." (Papafragou & Musolino 2003). There is also some variation reported across languages in the timing of scalar implicature acquisition, especially when the languages do not have scales with exactly the same meaning (Siegal et al. 2007), but overall the pattern seen throughout scales and throughout languages is one of young children behaving as if they had more "logical" interpretations than adults.

There is continuing debate over why children are more accepting of underinformative sentences than adults, but at least three alternatives have been suggested. Gualmini et al. (2001) and Chierchia et al. (2001) show that presenting alternative utterances to children (i.e. "Which is a better way to say it, X or Y?") increases the chance that children reject the underinformative. Their account of children's extra-logical interpretations is that the scalar implicature presents demands on overall cognitive processing, and that with proper modulation to make the task easier, children can calculate implicatures at adult-like levels. Katsos & Smith (2010) and Katsos & Bishop (2010) argue instead that children do calculate the implicature like adults do, but have a higher "pragmatic tolerance" for underinformative descriptions and so will be less likely to reject what they calculate is an underinformative utterance. These studies show that when children are given gradient answer options, not just "accept/yes" or "reject/no", then children will pick a middle value in many cases of scalar implicature. This is taken to mean that they do calculate the implicature, but simply have a lower threshold for acceptance than adults. Finally, Barner et al. (2010) argue that the difference between adults and children is that adults have had more experience with the language, and so know what words are scalar alternatives of each other, while children have not yet acquired the knowledge of each scale. They show that children have a higher rejection

rate of underinformative sentences using ad hoc scales like (6), which share all of the required cognitive and behavioral requirements of a scalar implicature, but are not based on a memorized lexical scale.

- (6) a. Zoltan drank tea, hot chocolate, and Coke.
b. Zoltan did not drink coffee.

(where tea, hot chocolate, Coke, and coffee are the relevant drinks)

A difficulty in each of these L1 studies is that children are both socially and cognitively less mature than adults, and also have less language experience, so that it is difficult to dissociate these possibilities.

The second language (L2) acquisition literature on scalar implicatures is more sparse than the first language acquisition literature because there is little evidence that second language learners have difficulty with scalar implicatures. Most scales used in scalar implicatures studies have similar meanings and forms across languages, such as numbers, coordinators, and quantifiers. Not surprisingly, given an appropriate context, second language learners of English are able to appropriately reject underinformative sentences to the same extent as native speakers (Slabakova 2010), but it is of course possible in this case that they are able to transfer knowledge from their L1. One exception is when the two languages do not share the exact same semantic scale, such as when one language lacks the scale <the, a> because it doesn't make a distinction between definite and indefinite determiners. In the case of L2 Japanese learners of English, L2 learners have difficulty in the early stages of acquisition, at first incorrectly transferring

knowledge about scales in their L1 (Japanese) to their L2 (English), but advanced learners do not differ in proficiency from native speakers (Gruter et al. in press).

In sum, children differ from adult responses to scalar terms, either because they are cognitively immature (either unable to handle the processing load, or have not yet learned proper pragmatic responses) or they do not yet have enough experience with the language (and so they don't know the scales). Second language learners are cognitively mature and have less experience with language, but they do not make a good test case because they can so easily transfer scales from their L1. Thus, it is difficult to test the role of cognitive maturity versus linguistic knowledge in many populations.

In this paper, we ask how deaf adult native signers of ASL compare with deaf adult non-native signers, who learned their first language later in life. There are a large number of signers who could be considered "non-native" because the great majority of deaf children are born to hearing parents who do not sign (exact numbers are difficult to determine, see Mitchell & Karchmer 2004), and so are unable to acquire in full the language of their caregivers from birth. In the USA, deaf children of hearing parents may be exposed to sign language at various ages (anytime from before entering school to after attending college), during which time they are also exposed to varying amounts of English. Importantly, neither language can be learned in a typical, native manner for these nonnative signers, and so despite otherwise normal cognitive abilities, many signers have been shown to have deficits as adults in processing complex linguistic grammar structures even after many years of using ASL (Mayberry et al. 2002; Mayberry 2010).

As noted by Siegel & Surian (2004), this group can provide a test case for the role of language experience in pragmatic phenomena because they are cognitively normal, but

lack the normal linguistic development of most L1 and L2 speaking adults. In other linguistic domains (e.g. syntax), late first language learners behave more like first language learners than second language learners, even though in age they are closer to L2 learners (Mayberry et al. 2002; Boudreault & Mayberry 2006). Unlike typical L1 acquisition, though, they do not always proceed through all of the final stages of typical development, but are often permanently lacking the full extent of native language competency. Crucially, these deaf nonnative signers of ASL are not learning ASL in the typical second language learning situation, where there is the possibility of transfer from a first language. Rather, the signers who participated in this paper did not learn either ASL or English as a true L1 from birth. Instead, they were usually exposed to a mixture of English and ASL. For all of the deaf participants in this study there was an ever-present bilingualism, but in no case was there an L1 learned from birth from which to transfer the ASL scalar implicature task.

Due to their adult-like world knowledge but potential for a lack of L1 from which to transfer scalar implicatures, we can begin to separate language knowledge from world knowledge in scalar implicatures. Because children respond differently to a prototypical scale versus numerals and other potential scales, we investigated signers' calculation of scalar implicatures based on three different types of scales: (a) quantifiers, (b) spatial, and (c) coordination, as well as a fourth sentence type, (d) relative clauses, to test signers' proficiency in nonmanual marking in ASL.

Quantifiers

Davidson (Chapter 2, this dissertation) showed that a scale based on quantifiers <all, some> in ASL generates implicatures for native signers that are not significantly different from scalar implicatures based on the <all, some> scale in English, allowing these quantifiers to serve as a baseline scale in ASL in scalar implicature studies. Therefore, the quantifier scale was used as a the example of a prototypical scale for the current experiment, and the version of the quantifiers SOME and ALL that were used are shown in Figure 4.1.

Figure 4.1. SOME and ALL used in the Quantifier sentence type.

Late ASL learners' interpretation of sentences on these quantifier scale sentences forms the crucial test for the role of language in scalar implicature acquisition: if cognitive maturity is the main reason that children fail at scalar implicatures, then we would expect all adult signers to perform similarly on computing scalar implicatures based on this scale. If, however, children's behavior is related to their not understanding the scalar relationship between words like "some" and "all", then adult signers may vary in their

calculation of these prototypical scalar implicatures based on whether they were exposed to ASL early in childhood or later.

Spatial Ad hoc

To contrast with the prototypical quantifier scale, we also included a sentence type based on an ad hoc scale, similar to example (6) above, except that all items in the context were of the same type (e.g. all bears instead of tea and hot chocolate, etc.). We included this spatial ad hoc scale in the current experiment because it does not require knowledge of a scalar relationship between two specific words like "some" and "all", but it does require the rest of the steps in the process: an ability to compare two possible descriptions and decide whether to accept or reject an underinformative description. If the knowledge of the scalar relationship of lexical items is the main difficulty that children are facing, we predict a difference between early- and late-learning deaf adults on the prototypical quantifier scale but not on this spatial ad hoc scale.

There is an additional aspect of the ad hoc scale in ASL used here: it includes spatial information via the classifier system. In Davidson (Chapter 2, this dissertation) native signers of ASL were marginally more likely to draw implicatures on ad hoc scales in ASL than native speakers were in English, who were in general more flexible in their ad hoc interpretations. The difference between the two languages was that the scale seen in the ASL sentences made use of the visual/manual modality to express the spatial layout of a scene. For example, to describe the configuration of two forks on a table, an English speaker can combine gesture and words to say "There is a fork here [gesture to

location X] and here [gesture to location Y]". In ASL, this locational information can be incorporated directly into the language, as in the sentence shown in (7).

____br

(7) BEAR CL:5(claw)_X, CL:5(claw)_Y, CL:5(claw)_Z.

"There is a bear here (in location X) and here (in location Y) and here (in location Z)."

In (7), the signer begins with the sign for the noun "bear", which as the topic of the sentence is accompanied by eye-brow raising prosodic/nonmanual marking, notated by the "br" for "brow raising" with the line above the sign indicating duration of the brow raising. She then uses the classifier in ASL appropriate to the size and shape of the toy bears, which is a clawed 5 handshape. The classifier is always notated as "CL", and what follows the colon is the shape of the classifier (here, "5(claw)"), following the conventions used in Sandler and Lillo-Martin (2006). Finally, the classifier is established in an area of the signing space, of which there are three in this sentence, marked "X", "Y", and "Z", notated as a subscript following the handshape. Frame-by-frame signs are shown in Figure 4.2(a) for the sentence in (7), and in Figure 4.2(b) for the less informative alternative sentence that only mentions two of the toy bears.

____br

a. BEAR CL:5(claw)_X, CL:5(claw)_Y, CL:5(claw)_Z.

____br

b. BEAR CL:5(claw)_Y, CL:5(claw)_Z.

Figure 4.2: 3 item and 2 item trials used in the Spatial sentence type.

Through these spatial ad hoc scales then we can not only test signers' interpretations of ad hoc scales to see if they have the correct tools for implicature calculation, but we can know that they were not directly transferring from English because the spatial information required for these inferences is unique to the visual-manual modality.

Coordination

We also investigated signers' interpretations of a third set of sentences that was based on a coordination scale, shown in English above in example (3) using "and" (which conveys conjunction in English) and "or" (which conveys disjunction). In ASL, a frequently utilized strategy for conveying these concepts are general use coordinators (notated COORD), which can be interpreted as either conjunction or disjunction depending on the context and other linguistic cues like nonmanual marking (Davidson, Chapter 3, this dissertation). As an example, MARY DRINK TEA COORD COFFEE can either be interpreted as "Mary drinks tea and coffee" or "Mary drinks tea or coffee." We included the coordination scale in ASL because, like the ad hoc scales, it is not based on a memorized lexical contrast, but unlike ad hoc scales, they are formed by two scalemates that have a context independent relationship. We know that disjunction in English generates scalar implicatures, so if the generalizable semantic relationship is the contributing cause of scalar implicature we do not expect a difference between ASL and English. If, on the other hand, there is a difference between the two languages, this would point towards lexical contrast as an important factor in scalar implicature calculation.

There are two types of general use coordinators to choose from in ASL: COORD-shift and COORD-L (Davidson, Chapter 3, this dissertation). In this experiment, the sentences are very simple, and COORD-L was reported to have prosodic restrictions when connecting very small clauses and nouns. Therefore, COORD-shift was used as the general use coordinator. When interpreted as disjunction, there was additional brow-raising nonmanual marking on disjuncts (see Figure 4.3) and this was labeled as

COORD-shift(or). The other use, without brow-raising and conveying conjunctive meaning, was labelled COORD-shift(and).

a. COORD-shift(and)

b. COORD-shift(or)

Figure 4.3: COORD-shift(and) and COORD-shift(or) used in the Coordination sentence type.

Relative Clauses

Signers were assessed for their interpretations of a fourth sentence type which was not a test of quantity implicatures, but was a potential challenge for a different reason: signers must use nonmanual (i.e. intonational) marking to disambiguate two strings of

signs which are exactly the same but differ in meaning based on nonmanual marking. As seen in Figure 4.4, the string of signs BEAR HUG DOG HAVE EARPHONES can mean "The bear who was hugging the dog had headphones" with the nonmanual marking seen in (a), that marks BEAR as the subject and HUG DOG as a subject relative clause. Alternatively, the same string can mean "The bear was hugging the dog who had the headphones", with the nonmanual marking seen in (b). Because of the linguistic subtlety required to detect the difference in meaning, we included them in the current experiment to create an independent measure of the ASL proficiency and nonmanual marking competency of the participants, to better understand how their scalar implicature calculation compares to interpretation of complex but non-scalar sentences in ASL.

_____br

a. BEAR HUG DOG HAVE EARPHONES.

Figure 4.4: The Relative Clause sentence type. Figure continued on next page.

b. BEAR HUG DOG HAVE HEADPHONES.

Figure 4.4 continued

In sum, if scalar implicatures are based on linguistic knowledge of scales that, like other linguistic structures, is difficult to learn without being able to map it onto a native L1, we expect to see a difference between early learning and later-learning deaf signers on the quantifier scale. If, on the other hand, scalar implicatures are based primarily on world knowledge and weighing of the meanings of alternatives, we should see no differences among signers on the quantifier scale. Both the spatial and coordination sentences require knowledge that cannot be transferred from English to ASL, and also require all of the steps of scalar implicature calculation except knowledge of a lexical scale. If lexical contrast is really the crucial information to acquire early, then we expect to see no difference between participants on these spatial and coordination scales in ASL. Finally, signers' performance on the relative clause scale allows us an independent measure of their ASL and specifically nonmanual competency.

Methods

Participants

Participants were 23 adults from the greater San Diego area who use American Sign Language and who self-identified as deaf. All were unable to hear speech, and all used ASL in their home, at work, or both. Participants were recruited directly through email requests from a laboratory database of interested participants or indirectly through recommendations by their friends and were reimbursed with cash or gift cards. Their chronological ages ranged from 19 to 59, and ages of ASL acquisition ranged from birth (native signers) to 18. Visual inspection of Figure 4.5 show two clearly separate groups: "Native" early signers who learned ASL from birth (Age of Acquisition(AoA) = 0, N=10) and "Late Nonnative" signers who learned ASL in their late teenage years (AoA = 16-19, N=7). The remaining 6 "Early Nonnative" signers had AoA ranging from 2 to 11.

Figure 4.5: Participants' ages of ASL acquisition compared to age at testing

Despite having learned ASL at varying ages and having a wide range of chronological ages at time of testing, all participants had extensive experience with ASL. The participant with the least ASL experience was 19 years old and learned ASL at age 16, while the next least experienced signer was 23 and learned ASL at age 17. Means for age, age of acquisition, and years of ASL are illustrated in Table 4.1.

Table 4.1: Number of participants and average age at testing, average age of ASL acquisition, and average years of ASL experience of each group of participants

	Number of Participants	Age at Testing	Age of ASL Acquisition	Years of ASL
Native Early ASL	10	37.1 (12.2)	0	37.1 (12.2)
Nonnative Early ASL	6	47.6 (9.2)	7.3 (3.3)	40.3 (7.8)
Nonnative Late ASL	7	44.7 (16.8)	17.1 (0.7)	27.6 (16.4)

Due to the heterogeneity of the participants, we analyzed our results using three motivated categorizations : (i) native signers' were compared to all nonnative signers (this analysis combines the early and late non-native signing groups); (ii) signers who learned ASL after childhood were compared to signers who learned natively or in early childhood (here the early non-native signers were grouped with native signers); (iii) age of acquisition was interpreted as a continuous variable using linear regression techniques. Each set of results are reported in turn below.

Procedures and Stimuli

Each testing session lasted 30-35 minutes. The participant sat at a laptop on a table, either at UCSD or at various meeting places throughout San Diego county. Both the instructions and the task itself were presented in ASL via the laptop in video form by a native signer. Participants were instructed that for each trial of the experiment, a picture would appear on the screen, and that after they looked at the picture, they should press the Space Bar key and a video description would begin to play next to the picture. Participants were told to press the smile face (the "1" key covered with a smile face sticker, directly below the picture of a smile face on screen) if they were "satisfied that the description matches the picture." If they were "not satisfied, and think that the description does not match the picture", they were instructed to press the frown face (the "0" key covered with a frown face sticker, directly below the picture of the frowning face on screen) (Figure 4.6). It was not possible to replay a video after it had begun playing.

Figure 4.6: Screenshot during an ASL Quantifier experimental trial. The picture appeared on the left, and the signed description on the right after the Spacebar is pressed.

Participants saw three practice trials to acquaint them with the task: (1) a picture of a red bowl, and a video description *THAT BOWL, RED* "the/that bowl is red."; (2) a picture of a white shoe, and a video description *THAT SHOE, BLACK* "the/that shoe is black; (3) a picture of a wooden spoon, and a video description *THAT SPOON, WOODEN* "the/that spoon is wooden." Participants had an opportunity to ask questions at this point if anything about the task or playing the videos was unclear. Practice trials were followed by further instructions, and a confirmation that the task was understood. Finally, 48 trials were presented, consisting of four sentence types: (a) quantifiers; (b) coordination; (c) spatial numbers; and (d) relative clause structures. Responses were recorded using Psyscope software.

In quantifier trials, each picture consisted of a set of three objects of which either some of the objects or all of them fulfilled a characterization about that object (e.g. red cans, lit candles, full glasses, etc.) A schema is shown in Figure 4.7, and the entire list can be found in the Appendix. Under the **Match** condition, the characterization applied to all of the objects (e.g. three cans, all red), and the description was accurate (e.g. *CANS, ALL RED* "All of the cans are red."). Under the **Mismatch** condition, the characterization applied to only two of the objects (e.g. three cans, only two are red), and the description was not accurate (e.g. *CANS, ALL RED* "All of the cans are red."). Finally, under the **Test** condition, the characterization applied to all of the objects (e.g. three cans, all red), and the description was not maximally informative (e.g. *CANS, SOME RED* "Some of the cans are red."). In this way, the scalar term *SOME* was only evaluated by participants in the Test condition, so that they were never directly comparing this condition to use of the

term when it was appropriate and maximally informative. Trials for quantifiers, spatial, and coordination sentence types mentioned below were counterbalanced so that each sentence frame (e.g. red cans) appeared in only one trial type (Match, Test, Mismatch) for each participant, and each third of participants saw the sentence frame in a different trial type.

In each of the spatial number trials, the picture showed either three or two objects. Again, the schema can be seen in Figure 4.7, and the full list is in the Appendix. In the **Match** condition in these trials, there were three objects laid out on the table, and the description was accurate both in number and in location of the items (e.g. BEAR CL:5(claw)_X, CL:5(claw)_Y, CL:5(claw)_Z. "There are three bears."). Under the **Mismatch** condition, the picture showed two objects, but the description was inaccurate and said there were three (e.g. BEAR CL:5(claw)_X, CL:5(claw)_Y, CL:5(claw)_Z. "There are three bears."). Finally, under the **Test** condition, the picture showed three objects, except now the description was not maximally informative, mentioning only two of the objects (e.g. BEAR CL:5(claw)_X, CL:5(claw)_Z. "There are two bears.").

In the coordination trials, the picture consisted of two different objects (e.g. a mug and a bowl), and then either one or two of the same type of object (e.g. spoons) in relation to the first objects. A schema can be seen in Figure 4.7, and the full list can be found in the Appendix. In the **Match** condition in these trials, each of the two different objects were related to one of the similar objects, and the description was accurate (e.g. HAVE SPOON IN CUP COORD-shift(and) SPOON IN BOWL. "A spoon is in the mug and a spoon is in the bowl."). Under the **Mismatch** condition, only one of the two

different objects were related to one of the similar objects, but the description said that they both were equally related (e.g. HAVE SPOON IN CUP COORD-shift(and) SPOON IN BOWL. "A spoon is in the mug and a spoon is in the bowl."). Under the **Test** condition, each of the two different objects were related to one of the similar objects, but the description was not maximally informative due to the disjunctive nonmanual marking on the general use coordinator (e.g. HAVE SPOON IN CUP COORD-shift(or) SPOON IN BOWL. "A spoon is in the mug or a spoon is in the bowl.").

In the relative clause sentence types, each picture consisted of two characters (e.g. a dog and a bear), a relationship between the characters (e.g. hugging) and one object (e.g. headphones). In the **Match** condition, the signed description involves a subject relative clause (e.g. [*topic* BEAR HUG DOG] HAVE EARPHONES), which is always a true description of the situation shown in the picture (e.g. the bear is hugging the dog and has the headphones). In the **Mismatch** condition, the signed description is an object relative clause (e.g. BEAR HUG [DOG HAVE HEADPHONES]) but the picture is the same as in the Match condition, so the description is false. Pictures were created in which the Mismatch sentence was true (e.g. the bear is hugging the dog and the dog has the headphones) and these were used to elicit the signed sentences for the Mismatch condition, but these pictures were never shown to participants. Participants each saw 6 Mismatch trials and 6 Match trials of the Relative Clause sentence type. Trials were counterbalanced so that each set of characters/relationship/object appeared in either the Match or Mismatch condition for each participant, and each half of participants saw them in opposite conditions. A scheme is shown in Figure 4.7 and a full list of trials is in the Appendix.

Results

In most linguistics research, and particularly psycholinguistics experiments such as scalar implicature studies, native signers are the standard by which we calibrate expectations of linguistic behavior. Following this tradition, we first present results from dividing our signers into native signers (learned ASL from birth and had at least one deaf parent) from all non-native signers (both early and late). Recall that participants' rejection of Test trials more than the Match trials indicates scalar implicature calculation, because the description is logically true (like the Match trial) but pragmatically infelicitous (unlike the Match trial). On each scale, nonnative signers as a group did succeed in drawing scalar implicatures: there were significant differences between their acceptance rate on the Test and Match trial for quantifiers ($t(12)=7.98$, $p<0.0001$), the spatial scale ($t(12)=51$, $p<0.0001$), and coordination ($t(12)=2.94$, $p<0.01$). There was also no significant difference between scalar implicature calculation by native signers and by nonnative signers on any of the scales, including quantifiers ($t(21)=0.41$, $p>0.1$), spatial ($t(21)=1.15$, $p>0.1$) and coordination ($t(21)=0.34$, $p>0.1$). Full means and standard deviations for all three scales by both native and nonnative signers can be seen in Table 4.2. Figure 4.8 compares performance on Test trials for native and nonnative signers.

Table 4.2: Mean rejection rates (with standard deviations) by Native and Nonnative signers for each sentence type.

		Match	Mismatch	Test
Quantifiers	Native	0.05 (0.16)	0.98 (0.08)	0.90 (0.13)
	Non-Native	0.13 (0.19)	0.96 (0.09)	0.87 (0.24)
Spatial	Native	0	1	0.97 (0.08)
	Non-Native	0.02 (0.07)	1	1
Coordination	Native	0.20 (0.19)	0.83 (0.17)	0.35 (0.21)
	Non-Native	0.12 (0.13)	0.87 (0.17)	0.38 (0.26)

There were also no significant differences between the two groups on control trials, on both the Match trials ($t(21)=1.12$, $p>0.1$ for quantifiers; $t(21)=0.87$, $p>0.1$ for spatial; $t(21)=1.24$, $p>0.1$ for coordination) and Mismatch trials ($t(21)=0.36$, $p>0.1$ for quantifiers; 100% agreement for spatial; $t(21)=0.58$, $p>0.1$ for coordination). Finally, the relative clause sentence type, which was included in this experiment as an independent measure of grammatical judgment, had overall scores ($M=0.59$, $SD=0.12$) that were above chance ($t(22)=3.48$, $p<0.01$) but showed no significant difference between native and nonnative signers ($t(21)=0.69$, $p>0.1$).

Figure 4.8: Native and Nonnative signers' rejection of underinformative sentences, indicating scalar implicature calculation

The second set of results is based on a grouping of participants into early and late learners, defined as those who learned ASL age 12 or earlier and those who learned ASL after age 12. There was still no significant difference between these two groups' rejection of test trials for the spatial scale ($t(21)=0.65$, $p>0.1$) and the coordination scale ($t(21)=0.64$, $p>0.1$). However, under this analysis one important difference did emerge: there was a significant difference between signers who acquired ASL early and late on the quantifier scale ($t(21)=2.29$, $p < 0.05$). Full means and standard deviations can be found in Table 4.3, and test trials are compared in Figure 4.9.

Table 4.3: Mean rejection rates (with standard deviations) by Early and Late ASL

Learning signers for each sentence type.

		Match	Mismatch	Test
Quantifiers	Early	0.08 (0.18)	0.95 (0.10)	0.94 (0.11)
	Late	0.14 (0.20)	1	0.75 (0.29)
Spatial	Early	0	1	0.98 (0.06)
	Late	0.04 (0.09)	1	1
Coordination	Early	0.16 (0.18)	0.88 (0.16)	0.39 (0.26)
	Late	0.14 (0.13)	0.79 (0.17)	0.32 (0.19)

There were also no significant differences between the two groups on control trials, on both the Match trials ($t(21)=0.78$, $p>0.1$ for quantifiers; $t(21)=1.67$, $p>0.1$ for spatial; $t(21)=0.18$, $p>0.1$ for coordination) and Mismatch trials ($t(21)=1.21$, $p>0.1$ for quantifiers; 100% agreement for spatial; $t(21)=1.21$, $p>0.1$ for coordination). Finally, the relative clause sentence type also showed no significant difference between these groups of signers ($t(21)=.11$, $p>0.1$).

Figure 4.9: Early and Late learners of ASL, rejection of underinformative sentences, indicating scalar implicature calculation

In addition to analyzing native versus nonnative signers and early learning versus late learning ASL signers, we also analyzed participants' scalar implicature calculation in a linear regression model with age of ASL acquisition, age, and relative clause task score as main factors in a full factorial analysis. Although age itself is not a typical predictor of language-related behavior, it was included as a factor in our model because the older signers tended to have later first ages of ASL acquisition and we anticipated that this could interact with their performance on the linguistic measures. Results of the analysis indicated that together, age of ASL acquisition, age, and relative clause task score did not explain a significant proportion of variance in accuracy scores for either the spatial sentence type, $R^2 = .10$, $F(7, 15) = 0.25$, $p > .1$, or the coordination sentence type, $R^2 = .23$, $F(7, 15) = 0.64$, $p > .1$, and no individual factor significantly predicted accuracy

scores in either sentence type. This contrasts with the same model for the quantifier sentence type, which did explain a significant proportion of variance for the accuracy scores, $R^2 = .76$, $F(7, 15) = 6.78$, $p < 0.001$. There was a significant main effect of both age of acquisition (slope = -0.012, $t(22) = -3.45$, $p < .01$) and age (slope = 0.008, $t(22)=3.79$, $p<0.01$) and a significant interaction of age and age of acquisition (slope = 0.001, $t(22)=2.69$, $p<0.05$), indicating that while older signers calculated more implicatures than younger signers, this was mainly true of early learning signers, and overall earlier learning signers calculated more scalar implicatures than later learning signers. Relative clause task score was not a significant predictor of accuracy on the quantifier sentence type, and did not significantly interact with other factors.

Discussion

The goal of this paper was to investigate developmental factors involved in scalar implicature calculation by looking closely at the pragmatic skills of a group of adults: deaf non-native signers of American Sign Language. These signers are cognitively mature adults but may have significantly reduced language experience due to acquiring their first language(s) later in life, and so can help dissociate the contributions of the linguistic and cognitive factors in the failure of typically developing children to provide adult-like pragmatic judgments.

Ten native signers provided the baseline by which to compare nonnative signers' judgment. When compared to all non-native signers, there was no difference between the group of native signers and the group of nonnative signers on any sentence type. However, the nonnative signers were clearly not a homogenous group: half of these

signers learned ASL quite late (either in high school or college), while the other half learned ASL while still young children. A different division of signers into early and late childhood ASL acquisition, as well as a linear regression model, showed that there is an age of ASL acquisition effect for the one prototypical scale studied, the quantifiers <all, some>.

One conclusion we draw from these results is that there is some evidence even among adults for some aspects of scalar implicatures being tied to language experience. Even the latest signers were mature adults who performed comparably to native signers on the spatial ad hoc and coordination scales and even the difficult relative clause sentences which required a proficiency in nonmanual marking. This performance, particularly on the spatial and coordination scales, indicates that they had the abilities necessary for the cognitive steps involved in implicature calculation. However, even though they still performed well on the quantifier scale, their decreased rejections compared to native speakers suggests that some aspects of scales is learned, and moreover, that this knowledge is most advantageously gained early in life.

It is important to note that the seven late learning signers are not a controlled group with respect to the early signers or native signers. Many factors could have played a role in their late ASL acquisition: often, children will learn to sign very late after oral methods (e.g. learning English) were unsuccessful for them in school, or they might be taught only in English or signed English until college, the age at which many of the late learning participants learned ASL. There could be any number of social or cultural reasons for these children to learn to sign so late, but whatever the cause, we

acknowledge that it is possible that this group may have other factors in common with each other outside of their language acquisition experience.

Despite the possibility of other factors being involved, we believe that these results are strengthened by our findings that, while the latest learners of ASL did not perform as well on the quantifier scale compared to earlier learners, that was not the case for the coordination or spatial sentence types. On the spatial sentence type, all signers performed extremely well, rejecting nearly all underinformative descriptions. From the point of view of what is required to appropriately reject this sentence, all of the same components are necessary as in the quantifier scale except for "scale" in the prototypical sense, based on two or more contrasting lexical items. For quantifiers, participants can call up the scale <all, some> to know that there is a better description (involving "all") of the picture, and then reject the underinformative description. For the spatial sentence type, there are no two lexical items that are compared; rather, rejection involves reasoning about an entire sentence. In this respect, it is like the ad hoc scale in (6), where adults infer from *Zoltan drank tea, hot chocolate, and Coke* that *Zoltan didn't drink coffee*. Children have no difficulty with these inferences, and we see here that neither do late learning ASL signers on the spatial sentence types. As mentioned, these late learners probably have extensive experience with English, but crucially, the spatial sentence types are unique to ASL, and cannot have been transfer from English. These results support the view that for prototypical scales like quantifiers, there is something linguistic that must be learned (the scale), and that language experience does play a role in learning these types of scalar implicatures.

In contrast to the other sentence types, all groups of signers performed quite poorly on the sentences involving coordination, accepting about as many descriptions as they rejected for the test case. Like the spatial sentence type, the Coordination sentence type is also not based on a lexical contrast, since the coordinators COORD-shift(and) and COORD-shift(or) differ only in nonmanual marking. Because signers showed no difficulty in rejecting inappropriate descriptions on the Mismatch sentence type, we know that they are aware of nonmanual marking and are able to make an appropriate distinction. We conclude then that when there is no explicit lexical contrast, as in the coordination scale in ASL, then there is not as much of a bias towards negating a stronger contrasting lexical item, and hence drawing the implicature. Again, because there is no lexical contrast to be learned, there seems to be no advantage for these type of scales to having learned the language at an early age.

There were also no differences among any groups of signers on the relative clause task, and it was not a significant factor in predicting accuracy on the other sentence types, including the prototypical scalar implicatures. Participants as a group performed above chance, but were not differentiated by any age of acquisition factors. We included these results because they show that even our latest learners of ASL in this experiment were quite proficient signers. In fact, we expect that in a group of less proficient signers, there may be even stronger age of acquisition effects on scales that require lexical knowledge, like quantifiers.

Many aspects of scalar implicature interpretation are still being debated in the literature, such as whether they are the result of a process of counterfactual reasoning about others' thoughts (Grice 1967; 1989; Russell 2006), of a conventionalized version of

this reasoning (Levinson 2000), or of a grammaticalized process (Chierchia 2006; Chierchia et al. to appear). This is a complex issue, but we believe that our results add one important piece of data to this debate. Our results suggest that sentences based on lexically contrast scale such as the quantifiers have a special status compared to other types of quantity implicatures. Later learners of ASL showed difficulty compared to native learners only on the quantifier scale, which required a conventionalized link between "some" and "all", while they behave the same on the non-lexical scales. Thus, not only is a conventionalized scale helpful for adults in computing implicatures, but it seems like it is helpful to learn such scales early in language development.

The small but important difference between early and late signers on quantifiers should not obscure the overall picture of overwhelming similarity among deaf signers of varying ages of ASL acquisition. This is generally not what has been found in other areas of linguistics such as syntax (Boudreault and Mayberry 2006), and suggests that much of pragmatic reasoning can be accounted for by general cognitive principles. This is consistent with an overall Gricean (1967; 1989) account of pragmatic abilities which are not language-specific, and even independent from the learning of any language. To be sure, although our sentences involved spatial phenomena, they were for the most part grammatically simple sentences, so more research should be done involving complex sentences and pragmatic phenomena to determine whether pragmatic abilities between signers of various backgrounds remains parallel when task difficulty increases. Whether they do, or not, we expect that when later learners must calculate alternatives based on lexical contrast, they may lag behind earlier learners in their scalar implicature interpretations.

Acknowledgements

Much gratitude to Marla Hatrak, Ivano Caponigro, Cami Miner, Corinne Brion, Carol Padden, Matt Hall, Susan Fischer, Brandon Scates, Peggy Lott, audiences at ESSLLI 2009 in Bordeaux, Gallaudet Brown Bag lunch, Polinsky Language Sciences lab at Harvard, the Center for Research in Language at UCSD, members of the UCSD Multimodal Language Development lab, San Diego Sign Language Reading Group, and UCSD Semantics Babble. Funding for this project was provided by a UCSD Linguistic Department Research grant and by the National Institute of Health predoctoral training grant #T32DC000041 through the Center for Research in Language at UCSD. This chapter, in full, is currently being prepared for submission for publication of all of the material presented here. [Davidson, Kathryn; Mayberry, Rachel]. The dissertation author was the primary investigator and author of this material.

Appendix: Experimental Stimuli

Quantifiers (*N.B. the first noun is topicalized with brow raising nonmanual marking*)

BALL, ALL/SOME YELLOW.

BOOKS, ALL/SOME OPEN.

CANDLE, ALL/SOME LIT.

CAN, ALL/SOME RED.

PENCIL, ALL/SOME BROKE.

BOWL, ALL/SOME YELLOW.

(Playing)CARD, ALL/SOME BLACK.

CUP, ALL/SOME FULL.

HANGER, ALL/SOME BROWN.

SHOE, ALL/SOME BLACK.

SOCK, ALL/SOME BROWN.

SPOON, ALL/SOME WOODEN.

Spatial (*N.B. Many clauses involve spatial classifiers, noted with (X,Y,Z) to indicate spatial placements*)

BALL CL:5(claw)_X CL:5(claw)_Y CL:5(claw)_Z.

BEAR CL:5(claw)_X CL:5(claw)_Y CL:5(claw)_Z.

BOWL CL:C_X CL:C_Y CL:C_Z.

CANDLE CL:C_X CL:C_Y CL:C_Z.

CAN CL:C_X CL:C_Y CL:C_Z.

CUP CL:C_X CL:C_Y CL:C_Z.

#DVD CL:B_X CL:B_Y CL:B_Z.

COLOR PEN CL:G_X CL:G_Y CL:G_Z.

PENCIL CL:G_X CL:G_Y CL:G_Z.

SHOE CL:B_X CL:B_Y CL:B_Z.

SPOON CL:G_X CL:G_Y CL:G_Z.

Coordination

HAVE BALL CL:5(claw)_X GLOBE CL:5(claw)_Y(behind X) COORD-shift(and/or)

SANDAL CL:B_W CL:5(claw)_X.

HAVE BEAR CL:V(curved)_X(inside cupped nondominant hand) WINE CL:C_X COORD-

shift(and/or) BOWL_Y CL:V(curved)_Y(inside cupped nondominant hand).

HAVE TOOTHBRUSH CL:G_X(inside cupped nondominant hand) MUG COORD-shift(and/or)

BOTTLE CL:G_X(inside cupped nondominant hand).

HAVE PLATE CL:C(half)_X CL:C(half)_Y [WHITE CANDLE CL:C_X(nondominant hand flat)

COORD-shift(and/or) BROWN CANDLE CL:C_Y(nondominant hand flat)]

HAVE COLOR MARKER [WALLET CL:B_X CL:G_X COORD-shift(and/or) GLOVE

CL:B_Y CL:G_Y]

HAVE PENCIL CL:G_X CEREAL #BOX CL:B(curved)_X COORD-shift(and/or) PENCIL

CL:G_Y #JUICE CL:C_Y

HAVE BOX_X PURSE_Y CEREAL #BOX CL:B_X(inside C shaped nondominant hand) COORD-

shift(and/or) CEREAL #BOX CL:B_Y(inside C shaped nondominant hand)

HAVE MEASURE [CL:C(reduced)`long thin object'] x [CL:U_X(inside C shaped nondominant hand)

BLACK CUP_X COORD-shift(and/or) GLASS [CL:C(reduced)`tall round

object']_Y CL:U_Y(inside C shaped nondominant hand)]

HAVE SCISSORS CL:3_X(on B shaped nondominant hand) BOOK COORD-shift(and/or) SHOE

CL:3_Y(on B shaped nondominant hand)

HAVE SOCK IN BLUE SHOE COORD-shift(and/or) SOCK IN BROWN SHOE.

HAVE SPOON IN CUP COORD-shift(and/or) SPOON IN BOWL.

HAVE #TOWEL PINEAPPLE CL:5(claw)_X CL:B_X(on top) COORD-shift(and/or) BOOK

CL:B_Y CL:B_Y(on top)

Relative Clause (*N.B. the first three signs are topicalized using brow raise nonmanual*

marking as shown in one condition, and are not topicalized in the other)

(_____ br)

BEAR HUG DOG HAVE HEADPHONES.

(_____ br)

BEAR STARE-AT TIGER HAVE CANDY.

(_____ br)

BEAR RIDING RABBIT HAVE COIN.

(_____ br)

WOMAN CARRY BEAR HAVE CANDY.

(_____ br)

MAN CATCHING WOMAN HAVE PURSE.

(_____ br)

FATHER TOUCHES SON HAVE RING.

(_____ br)

BEAR HOLD WOMAN HAVE BOWTIE.

(_____br)
BEAR PUSH DOG HAVE BANDAGE.

(_____br)
FISH BITE BEAR HAVE PURSE.

(_____br)
BOY RIDING BEAR HAVE KEY

(_____br)
RABBIT CHASING DOG HAVE BALL

(_____br)
WOMAN SIT-ON DOG HAVE CANDY.

References

- Barner, D., Brooks, N., & A. Bale (2010). "Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference." *Cognition* 118(1), 84-93.
- Boudreault P., & R. Mayberry (2006). "Grammatical processing in American Sign Language: Age of first-language acquisition effects in relation to syntactic structure." *Language and Cognitive Processes* 21, 608–635
- Chierchia, G. (2006). "Broaden Your Views: Implicatures of Domain Widening and the "Logicality" of Language." *Linguistic Inquiry* 37(4). 535-590.
- Chierchia, G. Fox, D. & B. Spector (to appear) "The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics." in Portner, P, Maienborn, C. & K. von Heusinger (eds.), *An International Handbook of Natural Language Meaning*, Mouton de Gruyter.
- Chierchia, G., Crain, S., Guasti, M. T., Gualmini, A., & L. Meroni (2001) "The Acquisition of Disjunction: Evidence for a Grammatical View of Scalar Implicatures," in A. H.-J. Do et al., eds., *BUCLD 25 Proceedings*, Cascadilla Press, Somerville, Massachusetts.
- Davidson, K. (Chapter 2, this dissertation). "Scalar Implicatures in a Signed Language."
- Davidson, K. (Chapter 3, this dissertation). "Coordination in ASL: a Study of the Role of Lexical Contrast in Scalar Implicatures."
- Grice, H. (1967; revised and published 1989). *Studies in the Way of Words*. Harvard University Press, Cambridge, MA.
- Gruter T, Lieberman M, & A. Gualmini (in press) "A test case for L1 versus UG as the L2 initial state: The acquisition of the scope properties of disjunction by Japanese learners of English." In: *Proceedings of Generative Approaches to Second Language Acquisition 9*, Cascadilla Press
- Gualmini, A., Crain, S., Meroni, L., Chierchia, G. & M.T Guasti, (2001). "At the semantics/pragmatics interface in child language." *Proceedings of Semantics and Linguistic Theory XI*, CLC Publications, Department of Linguistics, Cornell University, Ithaca, NY.
- Huang, Y. & J. Snedeker, (2009). "Semantic meaning and pragmatic interpretation in 5-year-olds: Evidence from real-time spoken language comprehension." *Developmental Psychology* 45(6). 1723-1739.
- Horn, L. (1989). *A Natural History of Negation*. University of Chicago Press: Chicago.

- Katsos, N. & D. Bishop (2011). "Pragmatic tolerance: Implications for the acquisition of informativeness and implicature." *Cognition* 120(1). 67-81.
- Katsos, N. & N. Smith (2010). Pragmatic tolerance and speaker-comprehender asymmetries. In Franich, K., Iserman, K. M., and Keil, L. L. (eds.), *Proceedings of the 34th Annual Boston Conference in Language Development*. Cascadilla Press, MA. 221-232.
- Levinson, S. (2000). *Presumptive Meanings: the theory of generalized conversational implicature*. MIT Press: Cambridge.
- Mayberry, R. (2010). "Early Language Acquisition and Adult Language Ability: What Sign Language Reveals About the Critical Period for Language." in Marschark, M, Spencer, P., and P. Nathan (eds.) *Handbook of Deaf Studies, Language, and Education*.
- Mayberry, R., Lock, E. & H. Kazmi (2002). "Linguistic ability and early language exposure." *Nature* 417, 38.
- Mitchell R., & M. Karchmer (2004). "Chasing the mythical ten percent: Parental hearing status of deaf and hard of hearing students in the United States." *Sign Language Studies* 4(2),138–163.
- Noveck, I. (2001). "When children are more logical than adults: Experimental investigations of scalar implicature" *Cognition* 78(2), 165-188.
- Noveck, I., & A. Posada (2003). "Characterizing the time course of an implicature: An evoked potentials study." *Brain and Language* 85(2). 203-210.
- Papafragou, A. & J. Musolino (2003). "Scalar Implicatures: experiments at the semantics-pragmatics interface." *Cognition* 86(3), 253-282.
- Russell, B. (2006). "Against Grammatical Computation of Scalar Implicatures." *Journal of Semantics* 23. 361-382.
- Sandler, W. & D. Lillo-Martin. (2006). *Sign Language and Linguistic Universals*
- Siegal, M. & L. Surian. (2004). "Conceptual Development and Conversational Understanding." *Trends in Cognitive Sciences* 8(12). 534-538.
- Siegal, M., Matsuo, A. & C. Pond (2007). "Bilingualism and Cognitive Development: Evidence from Scalar Implicatures." in Y. Otsu, (ed.) *Proceedings of the Eighth Tokyo Conference on Psycholinguistics*, Hituzi Syobo, Tokyo. 265–280.

Slabakova, R. (2010). "Scalar implicatures in second language acquisition." *Lingua* 120(10). 2444-2462.

van Rooij, R. & K. Schulz (2004). "Exhaustive interpretation of complex sentences." *Journal of Logic, Language and Information* 13, 491–519.

CHAPTER 5

Conclusion

This dissertation investigated scalar implicatures in American Sign Language to better understand the role of language-specific knowledge in this inferential process of natural language. Different aspects of language-specific knowledge were seen in each of the papers presented in Chapters 2-4. In Chapter 2, comparing scalar implicatures in the visual/spatial modality to the spoken language modality showed that there were vast similarities between the languages, with the exception of the ad hoc scale, which had spatial information in ASL that was lacking in English. Chapter 3 showed for the first time the various ways that coordination, especially disjunction, can be conveyed in ASL. This was followed by an experiment comparing participants' interpretations of a scale based on one of the general use coordination strategies in ASL with semantically similar but lexically contrastive scales in ASL and in English, finding that there were significantly less implicatures on sentences based on the scale that was not lexically contrastive. Finally, in Chapter 4 deaf signers who had acquired ASL at various ages were shown to be overwhelmingly similar in their scalar implicature calculation, with the one exception of the lexically-contrastive quantifier scale, on which earlier learners computed more implicatures than later learners. Overall, these results make contributions to three different areas: the study of sign language pragmatics, the role of lexical contrast in scalar implicatures, and the acquisition of scales through lexical contrast. Although each paper contains aspects of each, these correspond roughly to the three papers, and I will discuss each briefly in turn below.

5.1 Pragmatics in a Sign Language

One of the primary goals of this project was to progress the study of theoretical and experimental pragmatics in a signed language, focusing particularly on the interaction of pragmatics with semantics. Previously, scalar implicatures and other aspects of the semantics/pragmatics interface have been largely ignored in the growing body of work in sign language linguistics, and so this investigation of implicatures and the interpretation of coordination in American Sign Language begins to fill that gap.

The first contribution of the current work toward this goal was the creation of an experimental paradigm. The challenge in this case was to measure scalar implicature interpretations in a full sentence-to-picture matching task, while gathering linguistic judgments without English influence. The result was a Felicity Judgment Task in which participants could register their approval or disapproval through smile and frown faces, on a laptop which could be taken to various locations to increase participation. A future modification of this same design could include a gradient response system, using a spectrum of smile and frown faces. Research in spoken language experimental syntax suggests this would provide the same qualitative results (Fukuda et al. 2011; Sprouse 2011; Wescott & Fanselow 2011) but could have the added benefit of increasing statistical power in small subject sets, a frequent issue in sign language research.

The results of these experiment suggested that the paradigm was successful, and that as far as scalar implicatures are concerned, sign language pragmatics works much like spoken language pragmatics. English participants using the same video task on English sentences rejected underinformative sentences at rates consistent with previous research. Furthermore, ASL participants rejected ASL sentences that have similar

semantic properties to English sentences at rates that are no different from English participants' rejection rates. This puts scalar implicatures in ASL in line with those in previously studied spoken languages, and makes it possible to test for language and modality specific properties in ASL while making the most of comparisons to the large body of existing work in spoken languages.

Two modality-specific factors were present in the ASL sentences in Chapter 2: a more transparent relationship between form and meaning in the numbers one through five, and the size, shape, and spatial information in the ad hoc sentences that involved classifiers. Having a more transparent meaning-form mapping was found to have no effect on interpretation of sentences involving numbers, while adding spatial information to ad hoc scales did have a marginal effect of increasing rejection rates in ASL compared to English. This dichotomy is one reason that, generally, it is unhelpful to discuss "modality differences" as if there could be a unified phenomenon separating the effects of the visual versus auditory modality on language. Instead, what we see is that when it comes to pragmatic interpretation, different aspects of sign language specific phenomena have different effects. This becomes even more clear when comparing ASL participants' increased *rejection* of under-informative spatial ad hoc sentences in Chapter 2 with their increased *acceptance* of under-informative general coordination sentences in Chapter 3. Clearly, these behaviors are not due to an overall bias by participants towards being more accepting or rejecting of sentences compared to English, and this is confirmed by their behavior on control sentences. Rather, different aspects of the language cause different effects. In the case of spatial classifiers, one might be tempted to call the addition of spatial information a "modality effect" because it's not precisely clear what its correlate

would be in spoken language. However, in the case of coordination, it is clearly more appropriate to call it a language-specific effect, because the existence of general use coordinators is also reported in spoken languages, and so far it also has not been either confirmed or denied in other sign languages. If in the future other sign languages are found to have general use coordinators, and if they occur in sign languages at a higher rate than in spoken languages, we could consider this a modality bias, perhaps akin to the reported bias of increase rightward movement of wh-words in sign languages as compared to leftward movement in spoken languages (Cecchetto et al. 2009).

The issue of how classifiers interact with the rest of the grammatical structure of ASL is very much an open question. I will leave the creation of a comprehensive pragmatic theory of spatial classifiers to future research, except for one suggestion of comparing spatial classifiers with the same type of information in spoken languages, as in (1)-(2).

(1) THERE WALLET CL:B_X CANDLE CL:C_Y GLOBE CL:5(claw)_Z

"There is a wallet, a candle, and a globe."

(2) There is a flat wallet on the left, a chunky candle in the middle, and a small globe on the right.

If these sentences trigger similar pragmatic judgments by native users of each language, then we would also want a semantic theory of spatial classifiers incorporated into the grammatical computation of semantic content. If they are rated differently, it may instead

be the case that classifiers interact with the language in a different way, perhaps akin to gesture, which could be tested by comparing (1) with (3).

(1) THERE WALLET CL:B_X CANDLE CL:C_Y GLOBE CL:5(claw)_Z

"There is a wallet, a candle, and a globe."

(3) There is a wallet there [gesture to the left and indicate size], a candle there [gesture to the middle and indicate size], and a globe there [gesture to the right and indicate size].

In either case, I expect that it will be possible to find correlates in spoken language, but it might be the case that they are not what is traditionally thought of as language (for example, gesture), and in fact perhaps we may need to develop a more sophisticated way to incorporate this type of information into a pragmatic theory. However, even finding a comparison in a spoken language doesn't answer the question of *why* classifiers increased rejection of under-informative sentences, for which it may become necessary to turn to methods of quantifying utility and informational exchange such as Bates and MacWhinney (1987), Parikh (2001) or van Rooy (2004)¹ or to a change in the question under discussion (Roberts 1998).

5.2 Including Lexical Contrast in a Theory of Scalar Implicature

Besides contributing to the study of sign language pragmatics, the current work was also focused on a crucial question at the interface of semantics and pragmatics: how

¹ Thanks to Robert Kluender for this suggestion.

much of the calculation of implicatures is due to the language-specific form of the scalar items, and how much is due to conversational participants' considerations of propositional meaning and context. A consistent conclusion throughout each of the three papers presented in this dissertation was the importance of the role of lexical contrast among scalemates in scalar implicature calculation. In the first paper comparing ASL and English, the only marginal difference between these languages was on the scale that lacked a direct lexical contrast: the ad hoc scale. In English, this scale triggered quantitatively less implicatures than the prototypical scale, quantifiers. It also triggered less implicatures than the ad hoc scale in ASL, which included additional spatial information. It was concluded that when a lexical contrast was not present, interpretation was more flexible and other factors such as spatial information could affect interpretations. In the second paper investigating coordination in ASL, there was less scalar implicature calculation on the non-lexically contrastive coordination scale both within ASL compared to quantifiers, and between ASL and English coordination scales. The participants and the logical interpretations in these cases were the same with each set of comparisons, respectively, and so the difference in implicature calculation can be contributed to the one area in which the ASL coordination scale consistently differed from the others: lack of contrast between the lexical forms of the scalemates. Finally, in the third paper, we saw that most signers calculate implicatures at rates unrelated to their age of ASL acquisition, but the one age of acquisition effect that did appear was on the scale that involved lexical contrast, the quantifiers. On this scale, the early signers calculated more implicatures than later signers. All of these results point towards an

increased importance of lexically contrasting scalemates in the structure of a semantic scale.

In recent literature, the question of what, exactly, it means to be a scale had been largely secondary to questions about the steps after the scale triggered an implicature: whether the calculation is local and part of the syntax/semantics (Fox 2006; Sauerland 2011; Chierchia et al. to appear), a conventionalized inference originally based on the calculated meaning of the whole sentence (Levinson 2000), or a global inference calculated anew based on each context (Carston 1998). But none of these approaches can ignore the question of what triggers the implicature; the first two of these accounts essentially require some language-specific knowledge of "scales" to trigger implicatures. For Chierchia et al, the implicature occurs because of the presence of a silent operator akin to a silent "only" attaching to the scalar item, similar in meaning to the sentence "Only some tea contains caffeine" which clearly indicates that not all tea contains caffeine. The placement of this operator is conditioned on the placement of a scalar item like "some", so it is crucial to understand what makes certain words trigger the presence of "only" in the appropriate contexts (e.g. "some") and which do not (e.g. "green"). Similarly, in the conventionalized scalar implicature theory of Levinson (2000), when a scalar item like "some" is used, it will automatically trigger the implicature that "not all..." The main difference between these two theories is whether the implicature is done as part of the grammatical calculation or afterwards, but in both cases the triggering of the implicature is simply left to "the scale". In the third, relevance-based, account in which scalar implicatures are computed anew each time, a scale is not necessary, but it is a way to clarify what alternatives are under consideration to avoid overgenerating scalar

implicatures. Despite the importance of the scale in each of these theories, previous experimental literature had focused on when the scalar implicature interpretation begins and in what contexts it is available, and not the scale itself.

The current project focused on what triggers the process in the first place: do scalar implicatures get triggered because of the meaning of the sentence that was used, or is it because the user has the weak scale item such as "some" mentally connected with a strong item like "all"? And if the second, what types of words can be linked in the arrangement necessary to draw the implicature? Results showed that form of the scalar item, specifically lexical contrast, does play a role in scalar implicature calculation. Scales like <all, some> contrast one word with another and generate a high rate of scalar implicature calculation, while ad hoc scales like <(wallet, globe, and candle), (wallet and globe)> or general use coordination like <COORD-shift(and), COORD-shift(or)> in ASL have the same semantic structure in the same kind of sentence (a positive declarative using the stronger term entails the same sentence with the weaker term substituted), and yet generate less implicatures. This effect can be overcome: for example, we saw that in ASL when spatial information is added to an ad hoc scale it increases scalar implicature calculation, and it is likely that modifications to sentences based on the general coordination scale would do the same. Rather, it indicates that part of the reason that prototypical scales generate such strong implicatures for adults is not only that scalemates are in the same semantic class, of similar structural complexity, and of the same social register (Levinson 2000), but also because they are based on two different lexical items that are then linked to form a scale.

From the point of view of the previously mentioned theories of scalar implicature, this certainly supports the idea that implicatures could be triggered by something smaller than the sentence level, i.e. when you approach the word, it indicates that it is part of a scale. In the case of Chierchia, this prompts the addition of an "only" operator. In the case of Levinson, this triggers the full implicature (which is a statement) that, e.g. not all tea contains caffeine. So despite most of the research on scalar implicatures being concerned with the steps after the triggering, understanding that a lexical contrast triggers the implicature helps to clarify what options there are. This finding that the scalar item itself triggers the implicature also confirms what has been found in online processing studies, that eye gaze when processing scalar sentences indicates local implicature calculation around the scalar term (Storto & Tanenhaus 2005) and supports theoretical studies showing that some implicatures that speakers do calculate are not of the right form to have been calculated based on the whole sentence- rather, they are based on a local calculation (Sauerland 2011; Chierchia et al. to appear). From the evidence presented here and elsewhere, I conclude that scalar implicatures are of course dependent on context, but are triggered locally by the appearance of a scalar term that is mentally linked to a contrasting scalemate. The subsequent processes involved in scalar implicature calculation are unlikely to be especially grammatically complex, due to both late learners' abilities and also children's abilities on ad hoc scales. The following steps are left to the field of scalar implicature research concerned with the grammatical or pragmatic form of the implicature after it has been triggered.

One outstanding problem that remains in such a theory is the puzzle of detachability. Grice (1967, 1989) originally noted that "some" and "a few" mean essentially the same thing and also generate the same scalar implicature:

- (4) a. **Some** teas contain caffeine.
 (Not **all** teas contain caffeine.)
 b. **A few** teas contain caffeine.
 (Not **all** teas contain caffeine.)

On the one hand, the fact that the same semantics causes the same implicatures is a challenge to a theory in which the lexical form being linked to another lexical form is a crucial step. However, it's certainly not impossible to explain why both (4a) and (4b) generate the same implicature: both "some" and "few" would be linked to "all" in individual scales. These are both lexically contrastive scales, unlike ad hoc scales and scales based on general coordination. If <all, some> and <all, a few> are different scales, this would predict that children may develop the appropriate scalar implicatures based on these scales at different times. As far as I am aware neither the overall question of detachability or this prediction regarding acquisition have yet been tested empirically.

A second issue for a lexical theory of scalar implicature is that some scales can be created ad hoc, specific to a context, but are formed of contrasting lexical items. Examples of these are distance (5), ranks (6), and even fleeting concepts like fame (7)(Hirschberg 1985).

(5) On his drive north along the California coast, Zoltan made it to **Santa Barbara**.

(Zoltan did **not** make it to **San Francisco**.)

(6) Zoltan was an **assistant coach** for the Tritons.

(Zoltan was **not** the **head coach** for the Tritons.)

(7) Zoltan was a huge Beatles fan and once met **Ringo Starr** at a pub.

(Zoltan did **not** meet **John Lennon** (or Paul McCartney) in person.)

The "scales" <San Francisco, Santa Barbara>, <head coach, assistant coach>, and <John Lennon, Ringo Starr> are lexically-contrastive but likely not based on memorized links between words that always trigger implicatures, and yet they still generate implicatures in (5)-(7). The answer to these so-called "Hirschberg scales" may come from comparing them to the ad hoc scales in Chapter 2 such as <(wallet, globe, and candle), (wallet, globe)>. In these scales, as in the Hirschberg scales, the adult judgment is that the stronger term is not true, i.e. there is an implicature. However, we saw that empirically, these implicatures were more flexible than the lexically based scalar implicatures based on <all, some>. I predict that Hirschberg scales would exhibit flexibility similar to contextually based scales: the implicature would still be there, but depending on the context or the addition of other information (like spatial classifiers) it may be equally or less strong than the lexically based scale.

5.3 The Acquisition of Lexical Contrast

The nature of a semantic scale not only matters for understanding how scalar implicatures are triggered, but also helps clarify the process of acquiring scalar

implicatures, which children show quite different interpretations on than adults. One of the consequences of having a theory in which lexical contrast plays a role in triggering scalar implicatures is that the relationship between contrasting lexical items in a scales like <all, some> must be learned in addition to the meanings of the words on their own. Because each set of scalemates <all, some>, <and, or>, etc. must be learned as a linking of separate lexical items, and are not acquired from a general inference about how to calculate implicatures, this predicts that scales are learned one-by-one at different stages in life. This is supported by spoken language scalar implicature research showing that children succeed on scalar implicatures based on certain scales such as numbers or determiners earlier than other implicatures based on scales such as quantifiers or modals (Papfragou & Musolino 2003; Barner & Bachrach 2010). It is also consistent with children's early success with implicatures based on ad hoc scales, which involve the same steps as scalar implicatures but are not dependent on having learned a memorized scale (Barner et al. 2010). Finally, it is also supported by the difference we saw between early learning and late learning signers on the quantifier scale in Chapter 4, which suggests that not only are scales learned, but they may even be learned advantageously early in life.

One lingering question concerning acquisition is why task modulations make such a difference in calculation of scalar implicatures, particularly in children. In Noveck's (2001) original study showing that pre-school-age children fail to calculate implicatures, the children were simply asked to evaluate statements like "Some giraffes have long necks", which adults reject because a better and equally complex statement is "All giraffes have long necks". However, given that lexical contrast seems to play such an important role in scalar implicature calculation, if children haven't learned the scale yet,

they will be unable to draw the implicature. Barner et al. (2010) specifically provide this analysis of children's lack of scalar implicature calculation, and contrast it with numbers, where children typically do reject underinformative utterances, suggesting that this is because children know the contrasting alternatives to numbers but not to quantifiers. In current work (Sullivan et al. 2011), this question is being investigated in hearing pre-school-age children, who are asked to interpret sentences with scalar terms where they are explicitly given the scalar alternative. Results show that young children first actually *only* use contrast, so that they will even reject "All stars are painted" as a fulfillment of a request for "Some stars" to be painted. Adults overwhelmingly accepted such a case of overfulfillment. Later, children have learned that "All..." entails "Some...", but seem to not have learned that they are relevant alternatives for pragmatic reasons (i.e. a scale), and so accept "Some stars are painted" when all were requested, indicating a failure to draw the implicature. Finally, in the last stage, children correctly accept "All stars..." when all stars were requested, and reject "Some stars..." when all were, correctly drawing the scalar implicature. This all suggests that not only is lexical contrast important for an adult-like behavior of scalar implicature, but that our bias towards making use of contrast may cause children to alternatively succeed or fail on this task depending on their access to the entailment relationship and to alternatives, because they must override a bias towards contrast to learn the entailment relationship.

A second question about acquisition brought up by the current work is how such an acquisition story would work for scales like the general coordination scale in ASL, where the adult-like response is to generate less implicatures than for other scales. It seems that it would be difficult for children to learn a contrast for such a scale, as there

are no two words that can be linked to form this scale, only a modulation of nonmanual marking. Remnants of this difficulty may be part of the reason that there are less implicatures calculated by adults. A similar parallel between adults' behavior and children's behavior is also seen on the number scale, which is overwhelmingly rejected by adults more than other scales, as was seen in Chapter 2 of this dissertation, and is also a scale that children overwhelmingly accurately reject. In future work I hope to investigate children's acquisition of coordination scales in ASL, both those based on general use coordinators and also lexically contrastive coordinators to see if they are acquired at different rates that correspond to adults' different interpretations.

5.4 Final Thoughts

Many linguists consider an important goal of our field to be the creation of a model of how language works in humans, in order to allow more naturalistic computer interaction and to diagnose difficulties that children face on their way toward adult-like linguistic knowledge. In the case of scalar implicatures and other pragmatic inferences, this is a particularly difficult problem because it depends on knowledge of the language and also of the surrounding context and non-linguistic world knowledge. This interplay between language and context has been clear for a long time. What has been under debate for years is what is needed to be able to calculate an inference like a scalar implicature in the way that adults do: whether it is necessary to have some prior knowledge of how scalemates are related, or whether it is enough to be able to separately compute logical meaning and then consider Grice's maxims for each sentence.

The present work argues that the target adult-like implicature behavior is based on a lexical contrast between scalar items like "some" and "all", so that when the weak term is used, it triggers a scalar implicature. By investigating the structure of ASL, especially the use of general coordination, this conclusion was reached in a totally different experimental paradigm than online reading time studies, which also support the hypothesis that scalar implicatures begin locally, i.e. when the scalar word is used (Storto & Tanenhaus 2005; Panizza et al. 2009). This independent confirmation allows a better understanding of pragmatics not just as rules which apply to already formed sentences, but as guidelines for how language constructs meaning that may sometimes be grammaticalized (Chierchia et al. to appear) or conventionalized to the point of automaticity (Levinson 2000). Levinson (2000) suggests that even if inferences like scalar implicatures begin as full-fledged pragmatic inferences calculated anew each time, that it makes sense that they would evolve into "short-cut" inferences that are triggered by the same set of lexical items each time. He suggests that although it might initially seem like extra work to link a scalar term like "some" with a scalar implicature, in the long run it would be an efficient way to communicate. I suggest that it's not so much that "some" is linked with a scalar implicature, but that, along the lines of Horn, that the scale itself forms part of the triggering inference. When two lexical items are opposed to each other, as in <all, some>, they trigger the scalar implicature calculation.

The addition of lexical contrast as an important aspect of a semantic scale has consequences for how scalar implicatures are acquired. In addition to learning meanings of words and possible structural relationships of words, both children and artificial systems must also learn pragmatic connections between words, such as the lexical scale

<all, some>. This is likely to happen at different stages in language development for different scales, accounting for the differences in performance on scalar implicatures for difference scales and in different experimental contexts. Furthermore, we saw through reduced scalar implicatures on coordination in ASL that these scales are most easily linked to separate items in the lexicon, and not to prosodic variations of the same lexical item.

A final remark on the work presented in this dissertation is that it approached a question in semantics and pragmatics that has been investigated in English from the perspective of a new language and even new language modality: American Sign Language. Not only did this bring to light questions about pragmatics in sign languages, but it also made the most of the unique structure of ASL and background of signers to answer questions about the role of language-specific knowledge in scalar implicatures. These were conclusions that apply generally to scalar implicatures, and can in turn inform semantic theory. It is my hope that this type of research will continue not only in sign language semantics/pragmatics, but in general bringing facts from understudied languages to bear on the relationship between what our sentences mean and what we intend for them to convey.

References

- Barner, D., & A. Bachrach. (2010). "Inference and exact numerical representation in early language development." *Cognitive Psychology* 60(1). 40-62.
- Barner, D., Brooks, N., & A. Bale (2010). "Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference." *Cognition* 118(1), 84-93.
- Bates, E. & B. MacWhinney (1987) " Competition, variation, and language learning." in MacWhinney, B (ed.) *Mechanisms of Language Acquisition*. Erlbaum, N.J. 157-193.
- Carston, R. (1998). "Informativeness, relevance and scalar implicature." In R. Carston and S. Uchida (eds), *Relevance Theory: Applications and Implications*. Amsterdam: Benjamins. 179–236.
- Cecchetto, C., Geraci, C. & S. Zucchi. (2009) "Another Way to mark Syntactic Dependencies: The Case for Right-Peripheral Specifiers in Sign Languages" *Language* 85(2). 278-320.
- Chierchia, G. Fox, D. & B. Spector (to appear) "The Grammatical View of Scalar Implicatures and the Relationship between Semantics and Pragmatics." in Portner, P, Maienborn, C. & K. von Heusinger (eds.), *An International Handbook of Natural Language Meaning*, Mouton de Gruyter.
- Fox, D. (2006) "Free choice and the theory of scalar implicatures." in U. Sauerland and P. Stateva (eds.) *Presupposition and Implicature in Compositional Semantics*. Palgrave Macmillan, Basingstroke. U.K. 71-120.
- Fukuda, S., Goodall, G., Michel, D., & H. Beecher (2011). "Is Magnitude Estimation Worth the Trouble?" *Proceedings of the 29th West Coast Conference on Formal Linguistics*.
- Grice, H. (1967; revised and published 1989). *Studies in the Way of Words*. Harvard University Press, Cambridge, MA.
- Hirschberg, J. (1985). *A Theory of Scalar Implicature*. PhD Thesis, University of Pennsylvania
- Levinson, S. (2000). *Presumptive Meanings: the theory of generalized conversational implicature*. MIT Press: Cambridge.
- Noveck, I. (2001). "When children are more logical than adults: Experimental investigations of scalar implicature" *Cognition* 78(2), 165-188.

- Panizza, D., Chierchia, G., Huang, Y., & J. Snedeker, (2009). "The relevance of polarity for the online interpretation of scalar terms." presented at *Semantics and Linguistic Theory (SALT) 19*, Columbus, OH, April 2009.
- Papafragou, A. & J. Musolino (2003). "Scalar Implicatures: experiments at the semantics-pragmatics interface." *Cognition* 86(3). 253-282.
- Parikh, P. (2001). *The Use of Language*. Stanford: CSLI Publications.
- Roberts, C. (1998). "Information structure in discourse: Towards an integrated formal theory of pragmatics." Columbus: Ohio State Working Papers in Linguistics.
- Sauerland, U. (2011). "The Computation of Scalar Implicatures: Pragmatic, Lexical or Grammatical?" Unpublished manuscript. <http://semanticsarchive.net/>
- Sprouse, J. (2011). "A Test of the Cognitive Assumptions of Magnitude Estimation: Commutativity does not Hold for Acceptability Judgments" *Language* 87(2), 274-288.
- Storto, G. & M. Tanenhaus (2005). "Are scalar implicatures computed online?" In E. Maeir, Bary, C. & Huitink (Eds.), *Proceedings of Sinn und Bedeutung* 9, 431-445. Nijmegen: Nijmegen Centre for Semantics.
- Sullivan, J., Davidson, K. & D. Barner. (2011). "Conversational Implicature in Children." presented at *Boston University Conference on Language Development*, Boston, Ma. November 2011.
- van Rooy, R. (2004). "Utility, Informativity, and Protocols." *Journal of Philosophical Logic* 33(4). 389-419
- Weskott, T., & G. Fanselow (2011). "On the Informativity of Different Measures in Linguistic Acceptability." *Language* 87(2), 249-273.