

Instrumentals

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the degree of Doctor of Philosophy



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Date

Abstract

Bidi bidi bidi.

Acknowledgements

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Abbreviations

API	A pplication P rogramming I nterface
JSON	J ava S cript O bject N otation

Chapter 1

The Issue of Sign Language Grammars

Sign languages have been at the center of much debate about iconicity in linguistic encoding. Language researchers went from completely rejecting sign languages as natural, full-fledged languages to finding empirical tests to prove that they follow linguistic rules just as spoken languages do. Although some of the previous research on proving the linguistic status of sign languages had to ignore their iconic component, recent research takes iconicity as an inherent property of human language and central to understanding its intricacies, and pushes the limits of linguistic research in favor of abandoning the old black-or-white understanding of structured tools of interpersonal communication and bringing the threshold of required arbitrariness down as well as shifting its focus to more abstract concepts found in the building blocks of Language. In this dissertation, I study a highly iconic environment, instrumental constructions, in three unrelated sign languages with the aim of finding explanations to why signers make certain linguistic decisions and why their decisions show a great deal of variation. My findings show that there are multiple intertwined factors at play that lie not only internally to the linguistic system but also elsewhere externally, including preference and world knowledge. This dissertation takes a holistic approach to the phenomenon known as Language and seeks flexible answers to the stochastic behaviors of signers while building a model that relies on statistical and computational analyses of naturalistic data.

1.1 Introduction

This is the introduction. To include a citation to the text, just add the citation key shown in the references.bib file. The style of the citation is determined by the ref_format.csl file. For example, cite like this [Cousteau1963].

Sign languages use *classifier constructions* to encode certain grammatical relations. The term *classifier* was borrowed from studies conducted on spoken language morphology (XXXX – the classifier types person – Supalla?) and has since become a popular term to refer to many instances of different types of morphological markings. [INSERT: What are classifiers in spoken languages? Why are the structures in question called ‘classifier constructions’ in signed languages?]. Sign languages have a very extensive range of types of classifier use: from marking localizations in space to much more complex forms involving multiple discourse participants (XXXX – check SL classifier literature). The predicate of an instrumental utterance is a classic example of a complex classifier predicate and it is precisely what this dissertation is about.

[INSERT: Instrumental example and below insert a paragraph talking about how to try to stick with a simple example such as "cut with scissors"]

I take the space in this chapter to walk the reader from the general key concepts in sign language research to more specific areas concerning classifier constructions. I will then present some broader literature on instrumentals followed by the related work that has been done on sign language instrumental constructions. To be more precise, I will talk about high level topics that include (i) different levels of linguistic complexity in sign languages, (ii) how the morphologies of sign languages are structured and where they differ from those of spoken languages, (iii) gesture and how it permeates the grammatical fabric of sign languages, (iv) the interfaces of iconicity and arbitrariness in linguistic encoding and how that manifests in the lexicon. I will then dig deeper into more specific matters on (v) classifier predicates in sign languages, (vi) the semantics of instrumentals and (vii) instrumental utterances in sign languages, which will pave the way to the next chapter on the hypotheses and production data. By the end of this chapter, I will have shown to the reader that while sign languages are home to domain-specific structures, they do nonetheless follow the same abstract concepts as

spoken languages do such as argument and event structure, theta roles and morphemic representation.

1.2 Levels of Linguistic Complexity

Sign language linguistics lie in a secluded position within the dominant field of spoken language linguistics while also intersecting with the fields of psychology and gesture research. Despite the misunderstandings concerning sign languages and the limited availability of research on them, throughout many years of research they have proven to provide key concepts in understanding the human linguistic capabilities and cognitive processes which were previously unknown to researchers. Some of these concepts broaden the limits of the levels of linguistic representation and complexity which were once deemed to have reached their limits. Sign languages, despite their standalone positioning far from spoken languages, serve the same communicative purposes and functions that spoken languages do and enrich the ways linguistic complexity can manifest at the interdependent levels of phonological, morphological and syntactic representations.

p. 55 in Brentari - Complexity Complexity is a phenomenon much talked about in linguistics. Some forms are considered to be more complex than others and complexity comes in different flavors (insert Sinemaki and stuff here – both citations and discussion on complexity). Sign languages are no different than spoken ones with regards to complexity. In the case of classifier use to express instrumental meaning, we can talk about phonological, morphological, semantic and syntactic complexity. Phonological complexity can be perceived at the levels of ease of articulation of the phonological building blocks of a sign. Signs can be decomposed into phonemes, and phonemes are made up of sign features: handshape, movement and place of articulation (see Brentari, 1998; Sandler, 1989). Each handshape has an internal structure with varying complexity. Fewer features specifications mean less complexity. Less complex forms are more

prevalent than complex ones in language production (IS THIS TRUE? CITE IF IT IS – talk about DB’s framework here and say how certain sign languages tend to avoid the use of complex handshapes, then wrap up with how we won’t be looking at phonological complexity in this dissertation).

Morphemes and syllables are different levels of linguistic representation. The extent of a syllable is determined by how much dependent phonological material its nucleus can carry with respect to the specific phonological limitations of a language. For instance, Turkish does not allow onset consonant clusters (*CCV*, *CCVC*, **CCVCC*), while coda consonant clusters are allowed with certain restrictions that obey the sonority hierarchy (*CVCC*, *VCC*). In a recent computational study aiming to parse Turkish text into morphemes, I found that the most frequent syllable structure in Turkish is *CV* (*XY%*), followed by *CVC* (*XY%*), *VC*(*XY%*), *VCC*(*XY%*), *CVCC*(*XY%*) (total number of words: *XXX*, total number of syllables: *YYY*). Sign languages, as all natural languages do, respect certain rules in structuring their syllables and distributing their meaning bearing units, i.e. morphemes, across linguistic signals.

Sign languages use the gestural modality as an articulatory system to transmit information and the visual modality to as a perceptual system to receive it. Spoken languages, on the other hand, use different channels to transmit (vocal modality) and to receive (auditory modality) information. These most fundamental differences between the two prevalent modes of human language create a dichotomy of systems that serve the same purpose of communication but with discernible particularities in their subcomponents. The following in Table X.Y. from Meier (2002) summarizes the differences between signed and spoken languages in their articulatory and perceptual systems.

Table 1.1: Key differences between signed and spoken languages’ *articulatory* systems.

<i>Sign</i>	<i>Speech</i>
<ul style="list-style-type: none"> • Light source external to the signer • Articulators move in a transparent space, relatively massive and paired 	<ul style="list-style-type: none"> • Sound source internal to the speaker • Articulators largely hidden, relatively small and not paired

Table 1.2: Key differences between signed and spoken languages' *perceptual* systems.

<i>Sign</i>	<i>Speech</i>
<ul style="list-style-type: none"> • Signer must be in view of addressee • High spatial resolution of vision; lower temporal resolution than audition • Visual stimuli generally not categorically perceived • Articulatory gestures as the object of perception 	<ul style="list-style-type: none"> • Speaker need not be in view of addressee] • High temporal resolution of audition; lower spatial resolution than vision • Speech is categorically perceived • Acoustic events as the object of perception

These differences in the nature of the two modalities are manifested in how the atomic units of meaning as well as syllables are formed across modalities. Brentari (1998), argues that movement is the locus of sonority in a sign syllable and therefore visually the most salient part of a sign. She proves her point by discussing how an epenthetical movement is inserted when a sign underlyingly lacks a movement (e.g. the ASL sign THINK), pretty much an analog of how spoken languages break up consonant clusters with a semantically vacuous, phonologically unmarked epenthetical vowel that forms the nucleus of an otherwise missing syllable. Since sign languages, contra spoken languages, have multiple articulators with multiple joint sets at different anatomical levels, multiple, simultaneous movements happening at different joints is a possibility. This, however, according to Brentari, does not necessarily mean every single movement in a single time slot constitutes a syllable of its own. She argues that the longer movement in a sign will be the nucleus of the syllable. She shows that path movement is more sonorous than a local, smaller movement because it has more visibility for the interlocutor and is perceived as 'louder' than a local movement. Brentari (1998)'s SYLLABLE COUNTING CRITERIA in are as follows:

- a. The number of syllables in a sequence of signs equals the number of sequential movements in that string.
- b. When several shorter (e.g. trilled) movements co-occur with a single (e.g. path) movement of longer duration, the longer movement is the one to which the syllable refers – e.g. ASL DREAM, which is one syllable containing repeated trilled bending movements.

- c. When two or more movements occur at exactly the same time, it counts as one syllable, e.g. ASL INFORM is one syllable containing an aperture change and a path movement.

A different level of complexity, at the level of morphological representation, can be measured in terms of how semantically-loaded a linguistic form is. Sign languages differ from spoken languages in one important aspect: spoken languages tend to stack meanings horizontally while sign languages allow for heavier vertical stacking (CITE). This is known as sequential (horizontal) vs. simultaneous (vertical) morphology and has consequences for both how the morphology is structured and how it interacts with phonology and semantics. In other words, while a single sign is likely to be monosyllabic but polymorphemic, a single spoken morpheme tends to overlap with one or more syllables, oftentimes spanning multiple syllable nuclei. The following schemata in Figure 1.1 and the Turkish sentence in (1) illustrate this distinction.

(1) Sequential morphology – horizontal stacking (TURKISH)

Bakan-in özel istek-ler-i yerine getir-il-me-meli
 minister-GEN private request-PL-POSS grant-PASS-NEG-DEON
The minister's private requests should not be granted.

Figure 1.1(a) draws an impressionistic illustration of how syllables and morphemes tend to interact in certain spoken languages. One morpheme or less is available per one spoken syllable. In other words, the overall morpheme-to-syllable ratio in spoken languages is likely to be less than 1. The Turkish sentence in (2) has 4 phonological words with morpheme-to-syllable ratios of 0.66, 0.5, 0.75, 0.44. The sentence has 10 morphemes expressed in 18 syllables. The sentence-wide morpheme-to-syllable ratio is 0.55. This pattern

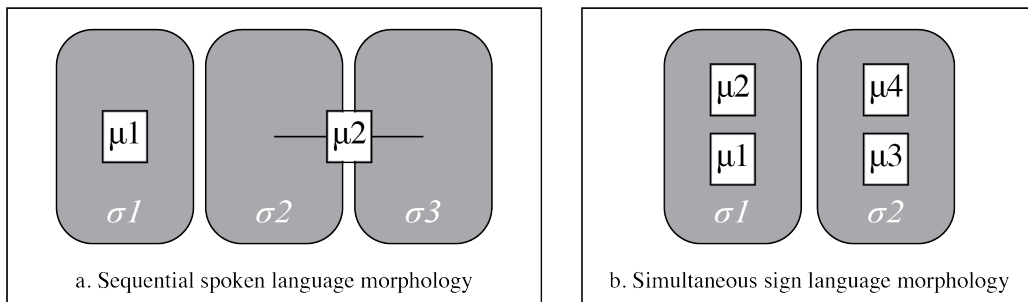


Figure 1.1: Impressionistic distribution of morphemes (μ) across syllables (σ) in the two modalities

of morphological sequentiality of spoken languages is, of course, not without exception. We see varying degrees of limited simultaneity especially in tone languages, Semitic languages¹, which have templatic morphologies, and also in small pockets of the morphologies of other spoken languages where contractions between two morphemes can occur². However, the general trend points toward a sequential morphology for spoken languages³ as depicted in Figure 1.1(a).

1.3 Maths

Numbered equations are assisted by installing pandoc-crossref:

$$\rho c \frac{\partial T}{\partial t} = \frac{\partial q}{\partial x} \quad (1.1)$$

Now you can reference your equations (eq. 1.1) inline. If using pandoc-crossref, add the following to each relevant section of the makefile.

```
--filter pandoc-crossref
```

Non numbered equations:

$$\rho c \frac{\partial T}{\partial t} = \frac{\partial q}{\partial x}$$

1.4 The middle bit

This is the middle bit. Phasellus quis ex in ipsum pellentesque lobortis tincidunt sed massa. Nullam euismod sem quis dictum condimentum. Sus-

¹Templatic morphologies allow for presets of vowel bundles to vertically come between and separate a two or three consonant-long abstract verbal root for derivational and inflectional purposes. For instance, the Arabic root *ktb* ‘read’ vertically merges with the templatic morpheme /CiCaC/ in a cogwheel manner and gives the noun *kitab* ‘book’ or merges with /Ca:CaC/ and gives *ka:tib* ‘clerk’. The same two templatic morphemes can merge with the root *htb* ‘address’ and give *hitab* ‘courtesy’ and *hatip* ‘preacher’ respectively. Notice that, while templatic morphology does work vertically, it operates over multiple syllables, which is different than the kind of simultaneity we find in sign languages.

²Such as the optional English /is/+/not/ > /isn’t/ or; The mandatory Turkish [i]-deletion in /gir/ **‘enter’** + /di/ PST + /im/ 1PS > gir.dim *‘I entered’*

³Other forms of simultaneity can be found in the oral modality. Speakers may choose to emphasize, for instance, that a movie was *‘looong’* by lengthening a vowel. This has an iconic flavor and it does not necessarily add an extra morpheme to the utterance.

pendisse risus metus, elementum eu congue quis, viverra ac metus. Donec non lectus at lectus euismod laoreet pharetra semper dui. Donec sed eleifend erat, vel ultrices nibh. Nam scelerisque turpis ac nunc mollis, et rutrum nisl luctus.

Cras eleifend velit diam, eu viverra mi volutpat ut. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec finibus leo nec dui imperdiet, tincidunt ornare orci venenatis. Maecenas placerat efficitur est, eu blandit magna hendrerit eu.

1.4.1 SUBSECTION OF THE MIDDLE BIT

This is a subsection of the middle bit. Quisque sit amet tempus arcu, ac suscipit ante. Cras massa elit, pellentesque eget nisl ut, malesuada rutrum risus. Nunc in venenatis mi. Curabitur sit amet suscipit eros, non tincidunt nibh. Phasellus lorem lectus, iaculis non luctus eget, tempus non risus. Suspendisse ut felis mi.

1.5 Summary of chapters

This is a brief outline of what went into each chapter. **Chapter 1** gives a background on dui tempus justo quis arcu consectetur sollicitudin. **Chapter 2** discusses morbi sollicitudin gravida tellus in maximus. **Chapter 3** discusses vestibulum eleifend turpis id turpis sollicitudin aliquet. **Chapter 4** shows how phasellus gravida non ex id aliquet. Proin faucibus nibh sit amet augue blandit varius.

Chapter 2

Literature review, with maths

2.1 Introduction

This is the introduction. Duis in neque felis. In hac habitasse platea dictumst. Cras eget rutrum elit. Pellentesque tristique venenatis pellentesque. Cras eu dignissim quam, vel sodales felis. Vestibulum efficitur justo a nibh cursus eleifend. Integer ultrices lorem at nunc efficitur lobortis.

2.2 The middle

This is the literature review. Nullam quam odio, volutpat ac ornare quis, vestibulum nec nulla. Aenean nec dapibus in mL/min⁻¹. Mathematical formula can be inserted using Latex:

$$(2) \ f(x) = ax^3 + bx^2 + cx + d$$

Nunc eleifend, ex a luctus porttitor, felis ex suscipit tellus, ut sollicitudin sapien purus in libero. Nulla blandit eget urna vel tempus. Praesent fringilla dui sapien, sit amet egestas leo sollicitudin at.

Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Sed faucibus pulvinar volutpat. Ut semper fringilla erat non dapibus. Nunc vitae felis eget purus placerat finibus laoreet ut nibh.

2.3 Conclusion

This is the conclusion. Donec pulvinar molestie urna eu faucibus. In tristique ut neque vel eleifend. Morbi ut massa vitae diam gravida iaculis. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas.

- first item in the list
- second item in the list
- third item in the list

Chapter 3

First research study, with code

3.1 Introduction

This is the introduction. Nam mollis congue tortor, sit amet convallis tortor mollis eget. Fusce viverra ut magna eu sagittis. Vestibulum at ultrices sapien, at elementum urna. Nam a blandit leo, non lobortis quam. Aliquam feugiat turpis vitae tincidunt ultricies. Mauris ullamcorper pellentesque nisl, vel molestie lorem viverra at.

3.2 Method

Suspendisse iaculis in lacus ut dignissim. Cras dignissim dictum eleifend. Suspendisse potenti. Suspendisse et nisi suscipit, vestibulum est at, maximus sapien. Sed ut diam tortor.

3.2.1 SUBSECTION 1 WITH EXAMPLE CODE BLOCK

This is the first part of the methodology. Cras porta dui a dolor tincidunt placerat. Cras scelerisque sem et malesuada vestibulum. Vivamus faucibus ligula ac sodales consectetur. Aliquam vel tristique nisl. Aliquam erat volutpat. Pellentesque iaculis enim sit amet posuere facilisis. Integer egestas quam sit amet nunc maximus, id bibendum ex blandit.

For syntax highlighting in code blocks, add three “” characters before and

after a code block:

```
mood = 'happy'  
if mood == 'happy':  
    print("I am a happy robot")
```

3.3 Results

These are the results. Ut accumsan tempus aliquam. Sed massa ex, egestas non libero id, imperdiet scelerisque augue. Duis rutrum ultrices arcu et ultricies. Proin vel elit eu magna mattis vehicula. Sed ex erat, fringilla vel feugiat ut, fringilla non diam.

3.4 Discussion

This is the discussion. Duis ultrices tempor sem vitae convallis. Pellentesque lobortis risus ac nisi varius bibendum. Phasellus volutpat aliquam varius. Mauris vitae neque quis libero volutpat finibus. Nunc diam metus, imperdiet vitae leo sed, varius posuere orci.

3.5 Conclusion

This is the conclusion to the chapter. Praesent bibendum urna orci, a venenatis tellus venenatis at. Etiam ornare, est sed lacinia elementum, lectus diam tempor leo, sit amet elementum ex elit id ex. Ut ac viverra turpis. Quisque in nisl auctor, ornare dui ac, consequat tellus.

Chapter 4

Research containing a figure

4.1 Introduction

This is the introduction. Sed vulputate tortor at nisl blandit interdum. Cras sagittis massa ex, quis eleifend purus condimentum congue. Maecenas tristique, justo vitae efficitur mollis, mi nulla varius elit, in consequat ligula nulla ut augue. Phasellus diam sapien, placerat sit amet tempor non, lobortis tempus ante.

4.2 Method

Donec imperdiet, lectus vestibulum sagittis tempus, turpis dolor euismod justo, vel tempus neque libero sit amet tortor. Nam cursus commodo tincidunt.

4.2.1 SUBSECTION 1

This is the first part of the methodology. Duis tempor sapien sed tellus ultrices blandit. Sed porta mauris tortor, eu vulputate arcu dapibus ac. Curabitur sodales at felis efficitur sollicitudin. Quisque at neque sollicitudin, mollis arcu vitae, faucibus tellus.

4.2.2 SUBSECTION 2

This is the second part of the methodology. Sed ut ipsum ultrices, interdum ipsum vel, lobortis diam. Curabitur sit amet massa quis tortor molestie dapibus a at libero. Mauris mollis magna quis ante vulputate consequat. Integer leo turpis, suscipit ac venenatis pellentesque, efficitur non sem. Pellentesque eget vulputate turpis. Etiam id nibh at elit fermentum interdum.

4.3 Results

These are the results. In vitae odio at libero elementum fermentum vel iaculis enim. Nullam finibus sapien in congue condimentum. Curabitur et ligula et ipsum mollis fringilla.

4.4 Discussion

Figure 4.1 shows how to add a figure. Donec ut lacinia nibh. Nam tincidunt augue et tristique cursus. Vestibulum sagittis odio nisl, a malesuada turpis blandit quis. Cras ultrices metus tempor laoreet sodales. Nam molestie ipsum ac imperdiet laoreet. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas.

4.5 Conclusion

This is the conclusion to the chapter. Quisque nec purus a quam consectetur volutpat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. In lorem justo, convallis quis lacinia eget, laoreet eu metus. Fusce blandit tellus tellus. Curabitur nec cursus odio. Quisque tristique eros nulla, vitae finibus lorem aliquam quis. Interdum et malesuada fames ac ante ipsum primis in faucibus.

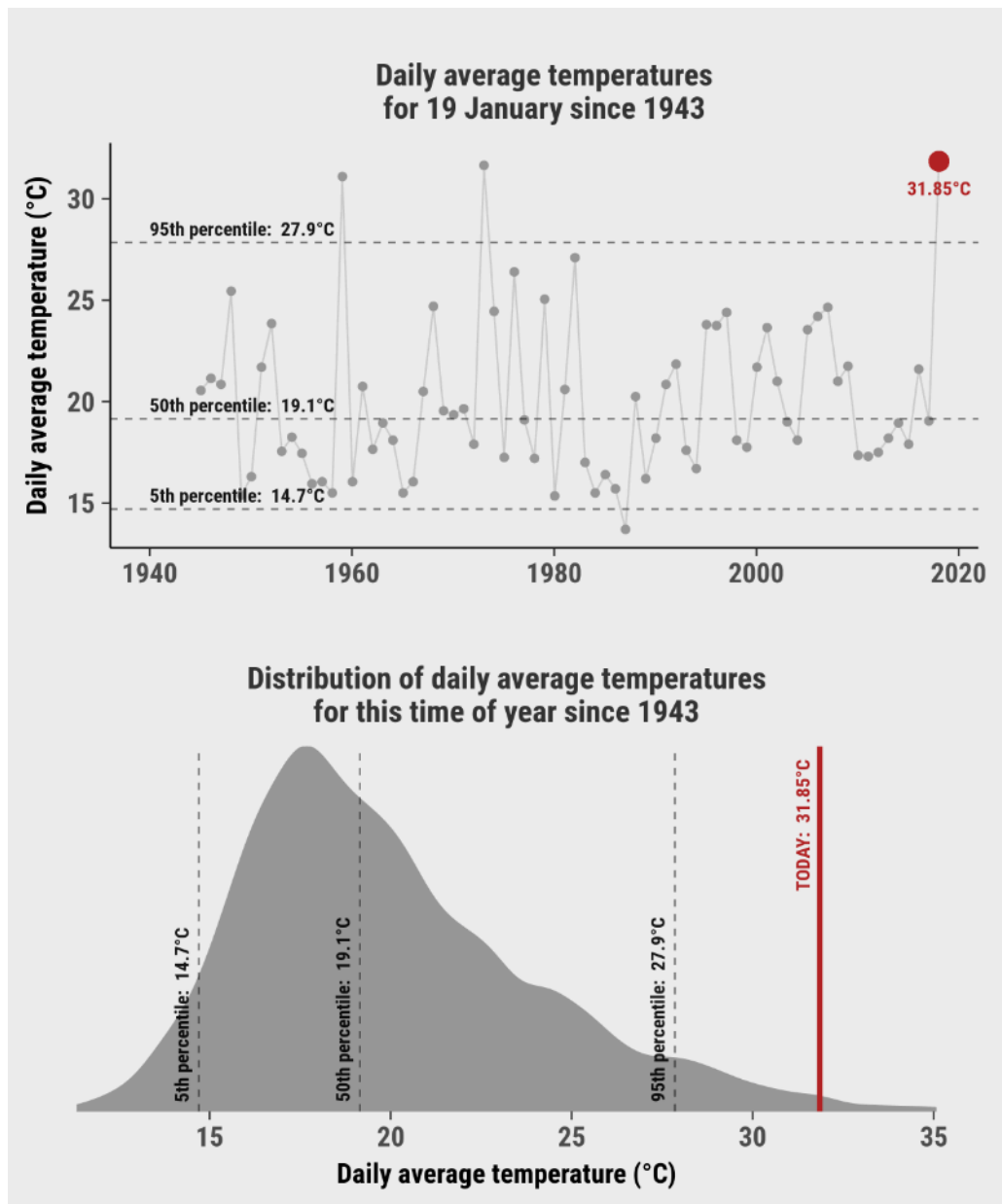


Figure 4.1: RV Calypso is a former British Royal Navy minesweeper converted into a research vessel for the oceanographic researcher Jacques-Yves Cousteau. It was equipped with a mobile laboratory for underwater field research.

Chapter 5

Research containing a table

5.1 Introduction

This is the introduction. Phasellus non purus id mauris aliquam rutrum vitae quis tellus. Maecenas rhoncus ligula nulla, fringilla placerat mi consectetur eu. Aenean nec metus ac est ornare posuere. Nunc ipsum lacus, gravida commodo turpis quis, rutrum eleifend erat. Pellentesque id lorem eget ante porta tincidunt nec nec tellus.

5.2 Method

Vivamus consectetur, velit in congue lobortis, massa massa lacinia urna, sollicitudin semper ipsum augue quis tortor. Donec quis nisl at arcu volutpat ultrices. Maecenas ex nibh, consequat ac blandit sit amet, molestie in odio. Morbi finibus libero et nisl dignissim, at ultricies ligula pulvinar.

5.2.1 SUBSECTION 1

This is the first part of the methodology. Integer leo erat, commodo in lacus vel, egestas varius elit. Nulla eget magna quam. Nullam sollicitudin dolor ut ipsum varius tincidunt. Duis dignissim massa in ipsum accumsan imperdiet. Maecenas suscipit sapien sed dui pharetra blandit. Morbi fermentum est vel quam pretium maximus.

5.2.2 SUBSECTION 2

This is the second part of the methodology. Nullam accumsan condimentum eros eu volutpat. Maecenas quis ligula tempor, interdum ante sit amet, aliquet sem. Fusce tellus massa, blandit id tempus at, cursus in tortor. Nunc nec volutpat ante. Phasellus dignissim ut lectus quis porta. Lorem ipsum dolor sit amet, consectetur adipiscing elit.

5.3 Results

Table 5.1 shows us how to add a table. Integer tincidunt sed nisl eget pellentesque. Mauris eleifend, nisl non lobortis fringilla, sapien eros aliquet orci, vitae pretium massa neque eu turpis. Pellentesque tincidunt aliquet volutpat. Ut ornare dui id ex sodales laoreet.

Table 5.1: This is the table caption. Suspendisse blandit dolor sed tellus venenatis, venenatis fringilla turpis pretium.

Column 1	Column 2	Column 3
Row 1	0.1	0.2
Row 2	0.3	0.3
Row 3	0.4	0.4
Row 4	0.5	0.6

5.4 Discussion

This is the discussion. Etiam sit amet mi eros. Donec vel nisi sed purus gravida fermentum at quis odio. Vestibulum quis nisl sit amet justo maximus molestie. Maecenas vitae arcu erat. Nulla facilisi. Nam pretium mauris eu enim porttitor, a mattis velit dictum. Nulla sit amet ligula non mauris volutpat fermentum quis vitae sapien.

5.5 Conclusion

This is the conclusion to the chapter. Nullam porta tortor id vehicula interdum. Quisque pharetra, neque ut accumsan suscipit, orci orci commodo tortor, ac finibus est turpis eget justo. Cras sodales nibh nec mauris laoreet iaculis. Morbi volutpat orci felis, id condimentum nulla suscipit eu. Fusce in turpis quis ligula tempus scelerisque eget quis odio. Vestibulum et dolor id erat lobortis ullamcorper quis at sem.

Chapter 6

Final research study

6.1 Introduction

This is the introduction. Nunc lorem odio, laoreet eu turpis at, condimentum sagittis diam. Phasellus metus ligula, auctor ac nunc vel, molestie mattis libero. Praesent id posuere ex, vel efficitur nibh. Quisque vestibulum accumsan lacus vitae mattis.

6.2 Method

In tincidunt viverra dolor, ac pharetra tellus faucibus eget. Pellentesque tempor a enim nec venenatis. Morbi blandit magna imperdiet posuere auctor. Maecenas in maximus est.

6.2.1 SUBSECTION 1

This is the first part of the methodology. Praesent mollis sem diam, sit amet tristique lacus vulputate quis. Vivamus rhoncus est rhoncus tellus lacinia, a interdum sem egestas. Curabitur quis urna vel quam blandit semper vitae a leo. Nam vel lectus lectus.

6.2.2 SUBSECTION 2

This is the second part of the methodology. Aenean vel pretium tortor. Aliquam erat volutpat. Quisque quis lobortis mi. Nulla turpis leo, ultrices nec nulla non, ullamcorper laoreet risus.

6.3 Results

These are the results. Curabitur vulputate nisl non ante tincidunt tempor. Aenean porta nisi quam, sed ornare urna congue sed. Curabitur in sapien justo. Quisque pulvinar ullamcorper metus, eu varius mauris pellentesque et. In hac habitasse platea dictumst. Pellentesque nec porttitor libero. Duis et magna a massa lacinia cursus.

6.4 Discussion

This is the discussion. Curabitur gravida nisl id gravida congue. Duis est nisi, sagittis eget accumsan ullamcorper, semper quis turpis. Mauris ultricies diam metus, sollicitudin ultricies turpis lobortis vitae. Ut egestas vehicula enim, porta molestie neque consectetur placerat. Integer iaculis sapien dolor, non porta nibh condimentum ut.

6.5 Conclusion

This is the conclusion to the chapter. Nulla sed condimentum lectus. Duis sed tempor erat, at cursus lacus. Nam vitae tempus arcu, id vestibulum sapien. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.

Chapter 7

Conclusion

7.1 Thesis summary

In summary, pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Nunc eleifend, ex a luctus porttitor, felis ex suscipit tellus, ut sollicitudin sapien purus in libero. Nulla blandit eget urna vel tempus. Praesent fringilla dui sapien, sit amet egestas leo sollicitudin at.

7.2 Future work

There are several potential directions for extending this thesis. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aliquam gravida ipsum at tempor tincidunt. Aliquam ligula nisl, blandit et dui eu, eleifend tempus nibh. Nullam eleifend sapien eget ante hendrerit commodo. Pellentesque pharetra erat sit amet dapibus scelerisque.

Vestibulum suscipit tellus risus, faucibus vulputate orci lobortis eget. Nunc varius sem nisi. Nunc tempor magna sapien, euismod blandit elit pharetra sed. In dapibus magna convallis lectus sodales, a consequat sem euismod. Curabitur in interdum purus. Integer ultrices laoreet aliquet. Nulla vel dapibus urna. Nunc efficitur erat ac nisi auctor sodales.

Appendix 1: Some extra stuff

Add appendix 1 here. Vivamus hendrerit rhoncus interdum. Sed ullamcorper et augue at porta. Suspendisse facilisis imperdiet urna, eu pellentesque purus suscipit in. Integer dignissim mattis ex aliquam blandit. Curabitur lobortis quam varius turpis ultrices egestas.

Appendix 2: Some more extra stuff

Add appendix 2 here. Aliquam rhoncus mauris ac neque imperdiet, in mattis eros aliquam. Etiam sed massa et risus posuere rutrum vel et mauris. Integer id mauris sed arcu venenatis finibus. Etiam nec hendrerit purus, sed cursus nunc. Pellentesque ac luctus magna. Aenean non posuere enim, nec hendrerit lacus. Etiam lacinia facilisis tempor. Aenean dictum nunc id felis rhoncus aliquam.

Chapter 8

References