Effect of online processing on linguistic memories

by

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Preface

At University of British Columbia (UBC), a preface may be required. Be sure to check the Graduate and Postdoctoral Studies (GPS) guidelines as they may have specific content to be included.

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Glossary

This glossary uses the handy `acroynym` package to automatically maintain the glossary. It uses the package's `printonlyused` option to include only those acronyms explicitly referenced in the LaTeX source.

CTAN The Common TeX Archive Network

DOI Document Object Identifier (see http://doi.org)

GPS Graduate and Postdoctoral Studies

RCS Revision control system, a software tool for tracking changes to a set of files

URL Unique Resource Locator, used to describe a means for obtaining some resource on the world wide web

Acknowledgments

Thank those people who helped you.

Don’t forget your parents or loved ones.

You may wish to acknowledge your funding sources.

Chapter 1

Introduction

If I have seen farther it is by standing on the shoulders of Giants.
— Sir Isaac Newton (1855)

This document provides a quick set of instructions for using the `ubcdiss` class to write a dissertation in LaTeX. Unfortunately this document cannot provide an introduction to using LaTeX. The classic reference for learning LaTeX is **?** 's book [**?**]. There are also many freely-available tutorials online; Andy Roberts' online LaTeX tutorials[1] seems to be excellent. The source code for this docment, however, is intended to serve as an example for creating a LaTeX version of your dissertation.

We start by discussing organizational issues, such as splitting your dissertation into multiple files, in Section 1.1. We then cover the ease of managing cross-references in LaTeX in Section 1.2. We cover managing and using bibliographies with BibTeX in Section 1.3. We briefly describe typesetting attractive tables in Section 1.4. We briefly describe including external figures in Section 1.5, and using special characters and symbols in Section 1.6. As it is often useful to track different versions of your dissertation, we discuss revision control further in Section 1.8. We conclude with pointers to additional sources of information in Section 1.10.

[1] http://www.andy-roberts.net/misc/latex/

1.1 Suggested Thesis Organization

The UBC Graduate and Postdoctoral Studies (GPS) specifies a particular arrangement of the components forming a thesis.[2] This template reflects that arrangement.

In terms of writing your thesis, the recommended best practice for organizing large documents in LaTeX is to place each chapter in a separate file. These chapters are then included from the main file through the use of `\include{file}`. A thesis might be described as six files such as `intro.tex`, `relwork.tex`, `model.tex`, `eval.tex`, `discuss.tex`, and `concl.tex`.

We also encourage you to use macros for separating how something will be typeset (e.g., bold, or italics) from the meaning of that something. For example, if you look at `intro.tex`, you will see repeated uses of a macro `\file{}` to indicate file names. The `\file{}` macro is defined in the file `macros.tex`. The consistent use of `\file{}` throughout the text not only indicates that the argument to the macro represents a file (providing meaning or semantics), but also allows easily changing how file names are typeset simply by changing the definition of the `\file{}` macro. `macros.tex` contains other useful macros for properly typesetting things like the proper uses of the latinate *exempli gratiā* and *id est* (i.e., `\eg` and `\ie`), web references with a footnoted URL (`\webref{url}{text}`), as well as definitions specific to this documentation (`\latexpackage{}`).

1.2 Making Cross-References

LaTeX make managing cross-references easy, and the `hyperref` package's `\autoref{}` command[3] makes it easier still.

A thing to be cross-referenced, such as a section, figure, or equation, is *labelled* using a unique, user-provided identifier, defined using the `\label{}` command. The thing is referenced elsewhere using the `\autoref{}` command. For example, this section was defined using:

```
\section{Making Cross-References}
\label{sec:CrossReferences}
```

[2]See http://www.grad.ubc.ca/current-students/dissertation-thesis-preparation/order-components

[3]The `hyperref` package is included by default in this template.

References to this section are made as follows:

```
We then cover the ease of managing cross-references in \LaTeX\
in \autoref{sec:CrossReferences}.
```

`\autoref{}` takes care of determining the *type* of the thing being referenced, so the example above is rendered as

> We then cover the ease of managing cross-references in LaTeX in Section 1.2.

The label is any simple sequence of characters, numbers, digits, and some punctuation marks such as ":" and "–"; there should be no spaces. Try to use a consistent key format: this simplifies remembering how to make references. This document uses a prefix to indicate the type of the thing being referenced, such as `sec` for sections, `fig` for figures, `tbl` for tables, and `eqn` for equations.

For details on defining the text used to describe the type of *thing*, search `diss.tex` and the `hyperref` documentation for `autorefname`.

1.3 Managing Bibliographies with BibTeX

One of the primary benefits of using LaTeX is its companion program, BibTeX, for managing bibliographies and citations. Managing bibliographies has three parts: (i) describing references, (ii) citing references, and (iii) formatting cited references.

1.3.1 Describing References

BibTeX defines a standard format for recording details about a reference. These references are recorded in a file with a `.bib` extension. BibTeX supports a broad range of references, such as books, articles, items in a conference proceedings, chapters, technical reports, manuals, dissertations, and unpublished manuscripts. A reference may include attributes such as the authors, the title, the page numbers, the Document Object Identifier (DOI), or a Unique Resource Locator (URL). A reference can also be augmented with personal attributes, such as a rating, notes, or keywords.

Each reference must be described by a unique *key*.[4] A key is a simple sequence

[4] Note that the citation keys are different from the reference identifiers as described in Section 1.2.

of characters, numbers, digits, and some punctuation marks such as ":" and "–"; there should be no spaces. A consistent key format simiplifies remembering how to make references. For example:

$\boxed{\textit{last-name}}$–$\boxed{\textit{year}}$–$\boxed{\textit{contracted-title}}$

where *last-name* represents the last name for the first author, and *contracted-title* is some meaningful contraction of the title. Then **?** 's seminal article on aspect-oriented programming [**?**] (published in **?**) might be given the key `kiczales-1997-aop`.

An example of a BibTEX `.bib` file is included as `biblio.bib`. A description of the format a `.bib` file is beyond the scope of this document. We instead encourage you to use one of the several reference managers that support the BibTEX format such as JabRef[5] (multiple platforms) or BibDesk[6] (MacOS X only). These front ends are similar to reference manages such as EndNote or RefWorks.

1.3.2 Citing References

Having described some references, we then need to cite them. We do this using a form of the `\cite` command. For example:

```
\citet{kiczales-1997-aop} present examples of crosscutting
from programs written in several languages.
```

When processed, the `\citet` will cause the paper's authors and a standardized reference to the paper to be inserted in the document, and will also include a formatted citation for the paper in the bibliography. For example:

> **?**] present examples of crosscutting from programs written in several languages.

There are several forms of the `\cite` command (provided by the `natbib` package), as demonstrated in Table 1.1. Note that the form of the citation (numeric or author-year) depends on the bibliography style (described in the next section). The `\citet` variant is used when the author names form an object in the sentence, whereas the `\citep` variant is used for parenthetic references, more like an end-note.

[5] http://jabref.sourceforge.net
[6] http://bibdesk.sourceforge.net

Table 1.1: Available `cite` variants; the exact citation style depends on whether the bibliography style is numeric or author-year.

Variant	Result
`\cite`	Parenthetical citation (e.g., “[**?**]” or “(**?** **?**)”)
`\citet`	Textual citation: includes author (e.g., “**?**]” or or “**?** (**?**)”)
`\citet*`	Textual citation with unabbreviated author list
`\citealt`	Like `\citet` but without parentheses
`\citep`	Parenthetical citation (e.g., “[**?**]” or “(**?** **?**)”)
`\citep*`	Parenthetical citation with unabbreviated author list
`\citealp`	Like `\citep` but without parentheses
`\citeauthor`	Author only (e.g., “**?** ”)
`\citeauthor*`	Unabbreviated authors list (e.g., “**?** ”)
`\citeyear`	Year of citation (e.g., “**?** ”)

1.3.3 Formatting Cited References

BibTEX separates the citing of a reference from how the cited reference is formatted for a bibliography, specified with the `\bibliographystyle` command. There are many varieties, such as `plainnat`, `abbrvnat`, `unsrtnat`, and `vancouver`. This document was formatted with `abbrvnat`. Look through your TEX distribution for `.bst` files. Note that use of some `.bst` files do not emit all the information necessary to properly use `\citet{}`, `\citep{}`, `\citeyear{}`, and `\citeauthor{}`.

There are also packages available to place citations on a per-chapter basis (`bibunits`), as footnotes (`footbib`), and inline (`bibentry`). Those who wish to exert maximum control over their bibliography style should see the amazing `custom-bib` package.

1.4 Typesetting Tables

?] made one grievous mistake in LATEX: his suggested manner for typesetting tables produces typographic abominations. These suggestions have unfortunately been replicated in most LATEX tutorials. These abominations are easily avoided simply by ignoring his examples illustrating the use of horizontal and vertical rules (specifically the use of `\hline` and `|`) and using the `booktabs` package instead.

The `booktabs` package helps produce tables in the form used by most professionally-edited journals through the use of three new types of dividing lines, or *rules*. Tables 1.1 and 1.2 are two examples of tables typeset with the `booktabs` package. The `booktabs` package provides three new commands for producing rules: `\toprule` for the rule to appear at the top of the table, `\midrule` for the middle rule following the table header, and `\bottomrule` for the bottom-most at the end of the table. These rules differ by their weight (thickness) and the spacing before and after. A table is typeset in the following manner:

```
\begin{table}
\caption{The caption for the table}
\label{tbl:label}
\centering
\begin{tabular}{cc}
\toprule
Header & Elements \\
\midrule
Row 1 & Row 1 \\
Row 2 & Row 2 \\
% ... and on and on ...
Row N & Row N \\
\bottomrule
\end{tabular}
\end{table}
```

See the `booktabs` documentation for advice in dealing with special cases, such as subheading rules, introducing extra space for divisions, and interior rules.

1.5 Figures, Graphics, and Special Characters

Most LaTeX beginners find figures to be one of the more challenging topics. In LaTeX, a figure is a *floating element*, to be placed where it best fits. The user is not expected to concern him/herself with the placement of the figure. The figure should instead be labelled, and where the figure is used, the text should use `\autoref` to reference the figure's label. Figure 1.1 is an example of a figure. A figure is generally included as follows:

```
\begin{figure}
\centering
\includegraphics[width=3in]{file}
```

LaTeX Rocks!

Figure 1.1: Proof of LaTeX's amazing abilities

```
\caption{A useful caption}
\label{fig:fig-label}   % label should change
\end{figure}
```

There are three items of note:

1. External files are included using the `\includegraphics` command. This command is defined by the `graphicx` package and can often natively import graphics from a variety of formats. The set of formats supported depends on your TeX command processor. Both `pdflatex` and `xelatex`, for example, can import GIF, JPG, and PDF. The plain version of `latex` only supports EPS files.

2. The `\caption` provides a caption to the figure. This caption is normally listed in the List of Figures; you can provide an alternative caption for the LoF by providing an optional argument to the `\caption` like so:

   ```
   \caption[nice shortened caption for LoF]{%
       longer detailed caption used for the figure}
   ```

   GPS generally prefers shortened single-line captions in the LoF: multiple-line captions are a bit unwieldy.

3. The `\label` command provides for associating a unique, user-defined, and descriptive identifier to the figure. The figure can be can be referenced elsewhere in the text with this identifier as described in Section 1.2.

See Keith Reckdahls excellent guide for more details, *Using imported graphics in LaTeX2e*[7].

1.6 Special Characters and Symbols

LaTeX appropriates many common symbols for its own purposes, with some used for commands (i.e., `\ { } & %`) and mathematics (i.e., `$ ^ _`), and others are automagi-

[7] http://www.ctan.org/tex-archive/info/epslatex.pdf

Table 1.2: Useful LaTeX symbols

LaTeX	Result	LaTeX	Result
\texttrademark	™	\&	&
\textcopyright	©	\{ \}	{ }
\textregistered	®	\%	%
\textsection	§	\verb!~!	~
\textdagger	†	\$	$
\textdaggerdbl	‡	\^{}	^
\textless	<	_	_
\textgreater	>		

cally transformed into typographically-preferred forms (i.e., – `') or to completely different forms (i.e., <>). Table 1.2 presents a list of common symbols and their corresponding LaTeX commands. A much more comprehensive list of symbols and accented characters is available at: http://www.ctan.org/tex-archive/info/symbols/comprehensive/

1.7 Changing Page Widths and Heights

The `ubcdiss` class is based on the standard LaTeX `book` class that selects a line-width to carry approximately 66 characters per line. This character density is claimed to have a pleasing appearance and also supports more rapid reading [**?**]. I would recommend that you not change the line-widths!

1.7.1 The `geometry` Package

Some students are unfortunately saddled with misguided supervisors or committee members whom believe that documents should have the narrowest margins possible. The `geometry` package is helpful in such cases. Using this package is as simple as:

```
\usepackage[margin=1.25in,top=1.25in,bottom=1.25in]{geometry}
```

You should check the package's documentation for more complex uses.

1.7.2 Changing Page Layout Values By Hand

There are some miserable students with requirements for page layouts that vary throughout the document. Unfortunately the `geometry` can only be specified once, in the document's preamble. Such miserable students must set LaTeX's layout parameters by hand:

```
\setlength{\topmargin}{-.75in}
\setlength{\headsep}{0.25in}
\setlength{\headheight}{15pt}
\setlength{\textheight}{9in}
\setlength{\footskip}{0.25in}
\setlength{\footheight}{15pt}

% The *sidemargin values are relative to 1in; so the following
% results in a 0.75 inch margin
\setlength{\oddsidemargin}{-0.25in}
\setlength{\evensidemargin}{-0.25in}
\setlength{\textwidth}{7in}        % 1.1in margins (8.5-2*0.75)
```

These settings necessarily require assuming a particular page height and width; in the above, the setting for `\textwidth` assumes a US Letter with an 8.5" width. The `geometry` package simply uses the page height and other specified values to derive the other layout values. The `layout` package provides a handy `\layout` command to show the current page layout parameters.

1.7.3 Making Temporary Changes to Page Layout

There are occasions where it becomes necessary to make temporary changes to the page width, such as to accomodate a larger formula. The `chngpage` package provides an `adjustwidth` environment that does just this. For example:

```
% Expand left and right margins by 0.75in
\begin{adjustwidth}{-0.75in}{-0.75in}
% Must adjust the perceived column width for LaTeX to get with it.
\addtolength{\columnwidth}{1.5in}
\[ an extra long math formula \]
\end{adjustwidth}
```

1.8 Keeping Track of Versions with Revision Control

Software engineers have used Revision control system (RCS) to track changes to their software systems for decades. These systems record the changes to the source code along with context as to why the change was required. These systems also support examining and reverting to particular revisions from their system's past.

An RCS can be used to keep track of changes to things other than source code, such as your dissertation. For example, it can be useful to know exactly which revision of your dissertation was sent to a particular committee member. Or to recover an accidentally deleted file, or a badly modified image. With a revision control system, you can tag or annotate the revision of your dissertation that was sent to your committee, or when you incorporated changes from your supervisor.

Unfortunately current revision control packages are not yet targetted to non-developers. But the Subversion project's TortoiseSVN[8] has greatly simplified using the Subversion revision control system for Windows users. You should consult your local geek.

A simpler alternative strategy is to create a GoogleMail account and periodically mail yourself zipped copies of your dissertation.

1.9 Recommended Packages

The real strength to LaTeX is found in the myriad of free add-on packages available for handling special formatting requirements. In this section we list some helpful packages.

1.9.1 Typesetting

`enumitem`: Supports pausing and resuming enumerate environments.

`ulem`: Provides two new commands for striking out and crossing out text (`\sout{text}` and `\xout{text}` respectively) The package should likely be used as follows:

```
\usepackage[normalem,normalbf]{ulem}
```

[8] http://tortoisesvn.net/docs/release/TortoiseSVN_en/

to prevent the package from redefining the emphasis and bold fonts.

chngpage: Support changing the page widths on demand.

mhchem: Support for typesetting chemical formulae and reaction equations.

Although not a package, the `latexdiff`[9] command is very useful for creating changebar'd versions of your dissertation.

1.9.2 Figures, Tables, and Document Extracts

pdfpages: Insert pages from other PDF files. Allows referencing the extracted pages in the list of figures, adding labels to reference the page from elsewhere, and add borders to the pages.

subfig: Provides for including subfigures within a figure, and includes being able to separately reference the subfigures. This is a replacement for the older `subfigure` environment.

rotating: Provides two environments, sidewaystable and sidewaysfigure, for typesetting tables and figures in landscape mode.

longtable: Support for long tables that span multiple pages.

tabularx: Provides an enhanced tabular environment with auto-sizing columns.

ragged2e: Provides several new commands for setting ragged text (e.g., forms of centered or flushed text) that can be used in tabular environments and that support hyphenation.

1.9.3 Bibliography Related Packages

bibunits: Support having per-chapter bibliographies.

footbib: Cause cited works to be rendered using footnotes.

[9] http://www.ctan.org/tex-archive/support/latexdiff/

`bibentry:` Support placing the details of a cited work in-line.

`custom-bib:` Generate a custom style for your bibliography.

1.10 Moving On

At this point, you should be ready to go. Other handy web resources:

- Common TeX Archive Network (CTAN)[10] is *the* comprehensive archive site for all things related to TeX and LaTeX. Should you have some particular requirement, somebody else is almost certainly to have had the same requirement before you, and the solution will be found on CTAN. The links to various packages in this document are all to CTAN.

- An online reference to LaTeX commands[11] provides a handy quick-reference to the standard LaTeX commands.

- The list of Frequently Asked Questions about TeX and LaTeX[12] can save you a huge amount of time in finding solutions to common problems.

- The teTeX documentation guide[13] features a very handy list of the most useful packages for LaTeX as found in CTAN.

- The `color`[14] package, part of the graphics bundle, provides handy commands for changing text and background colours. Simply changing text to various levels of grey can have a very dramatic effect.

- If you're really keen, you might want to join the TeX Users Group[15].

[10] http://www.ctan.org
[11] http://www.ctan.org/get/info/latex2e-help-texinfo/latex2e.html
[12] http://www.tex.ac.uk/cgi-bin/texfaq2html?label=interruptlist
[13] http://www.tug.org/tetex/tetex-texmfdist/doc/
[14] http://www.ctan.org/tex-archive/macros/latex/required/graphics/grfguide.pdf
[15] http://www.tug.org

Chapter 2

Background

Stuff I have researched

Chapter 3

Lexical decision

This chapter reports on two experiments done using a lexical decision paradigm to induce auditory perceptual learning in participants. This paradigm has been most used in the previous literature (Reinisch line of work, McQueen line of work, some kraljic? but I think some other kraljic uses shapes - maybe just for unlearning phase).

3.1 Motivation

A listener's perceptual system shifts rapidly; for instance, vowel perception can shift solely on the basis of the vowels in a preceding sentence [4]. Boundaries between fricative categories can be changed by exposure to relatively small amount of ambiguous fricative tokens, but they must be embedded within and associated with a lexical item in a language, and hearing ambiguous productions between two sound categories in nonwords does not induce perceptual learning [5]. However, besides the categorical distinction separating words from nonwords, little is known about the factors that influence linking an shifted or ambiguous production of a sound with a category through a lexical item. My dissertation investigates the factors which can contribute to associating ambiguous atypical productions with a specific sound category through lexical items.

Given a continuum from a nonword like *dask* to word like *task* that differs only in one sound, listeners in general are more likely to interpret any step along the continuum as the word endpoint rather than the nonword endpoint [2]. This lexical bias, also know as the Ganong effect, is exploited in perceptual learning studies to allow for noncanonical, ambiguous productions of a sound to be linked to pre-existing sound categories.

Lexical bias, however, has been shown to be gradient. When an ambiguous sound is embedded later in a word, listeners are more likely to treat the production as a word than if the same sound is embedded earlier in the word [6]. The same study found that when listeners are alerted to the ambiguous sound's presence, and told to listen carefully, lexical biases diminish overall, with listeners less likely to treat the production as a word. Most studies looking at boundaries between fricative categories use longer (2-3 syllable) lexical items ending with a fricative [5], but perceptual learning has also been found following exposure to shorter (1 syllable) lexical items beginning with an ambiguous sound [1]. However, specific comparisons in perceptual learning effects across word position in these studies is impossible due to differences in languages under investigation (Dutch or English) and the nature of contrast (/t/-/d/, /s/-/sh/, or /s/-/f/). Studies also differ on the ambiguity of the sound, with some attempting to control for the Ganong effect by picking an ambiguous sound farther away from the more canonical word form [7] and some selecting a production halfway in between word and nonword [5]. The first two experiments in my dissertation address this gap in the literature and investigate the mechanism underlying perceptual learning.

Given the difference in word response rates depending on position in the word, we would predict that listeners exposed to ambiguous sounds earlier in words would be less likely to accept these productions as words as compared to listeners exposed to ambiguous sounds later in words. In addition, given the reliance of perceptual learning on lexical scaffolding, this lower acceptance rate for the former group would lead to a smaller perceptual learning effect as compared to the latter group.

In these two experiments, listeners will be exposed to ambiguous productions of words containing a single instance of /s/, where the /s/ has been modified to sound more like /sh/ in a lexical decision task. In one group, the S-Initial group, the critical words will have an /s/ in the onset of the first syllable, like in *cement*, with no /sh/ neighbour, like *shement*. In the other group, the S-Final group, the critical words will have an /s/ in the onset of the final syllable, like in *tassel*, with no /sh/ neighbour like *tashel*. In addition, half of each group will be given instructions that the speaker has a ambiguous /s/ and to listen carefully, following Pitt and Szostak [6].

The two experiments differ in the salience of the ambiguous stimuli, with salience here defined as the distance from a normal, natural production. A pretest was conducted with 20 listeners to determine the percentage /s/ response at each step of the critical continua (for instance, from *tassel* to *tashel*). In the first experiment, the continua steps selected for the critical item were around 30% /s/ response, following Reinisch et al. [7]. In the second experiment, the continua steps selected for critical items were around 50% /s/ response, following other methodologies [3, 5], which should be more susceptible to lexical biases. The differences in perceptual learning between the groups are predicted be less in the first experiment than in second, as the lessened salience of the stimuli in the second experiment is predicted to allow for a greater role of top-down attention on the processing of the exposure items.

3.2 Experiment 1

3.2.1 Methodology

Participants

One hundred native speakers of English (mean age ??, range ??-??) participated in the experiment and were compensated with either $10 CAD or course credit. They were recruited from the UBC student population. Twenty additional native English speakers participated in a pretest to determine the most ambiguous sounds. Twenty five other native speakers of English participated for course credit in a control experiment.

Materials

One hundred and forty English words and 100 nonwords that were phonologically legal in English were used as exposure materials. The set of words consisted of

40 critical items, 20 control items and 60 filler words. Half of the critical items had an /s/ in the onset of the first syllable and half had an /s/ in the onset of the final syllable. All critical tokens formed nonwords if their /s/ was replaced with /sh/. Half the control items had an /sh/ in the onset of the first syllable and half had an /sh/ in the onset of the final syllable. Each critical item and control item contained just the one sibilant, with no other /s z sh zh ch or jh/. Filler words and nonwords did not contain any sibilants. Four monosyllabic minimal pairs of voiceless sibilants were selected as test items for categorization (*sack*-*shack*, *sigh*-*shy*, *sin*-*shin*, and *sock*-*shock*). Two of the pairs had a higher log frequency per million words (LFPM) from SUBTLEXus (cite) for the /s/ word, and two had higher LFPM for the /sh/ word. *Sack*-*shack* had frequencies of 1.11 LFPM and 0.75 LFPM, *sigh*-*shy* had frequencies of 0.53 LFPM and 1.26 LFPM, *sin*-*shin* had frequencies of 1.20 LFPM and 0.48 LFPM, and *sock*-*shock* had frequencies of 0.95 LFPM and 1.46 LFPM.

All words and nonwords were recorded by a male Vancouver English speaker in quiet room. Critical words for the exposure phase were recorded in pairs, once normally and once with the sibilant swapped forming a nonword. The speaker was instructed to produce both forms with comparable speech rate, speech style and prosody.

For each critical item, the word and nonword versions were morphed together in an 11-step continuum (0%-100% of the nonword /sh/ recording, in steps of 10%) using STRAIGHT (cite) in Matlab (cite). Prior to morphing, the word and nonword versions were time aligned based on acoustic landmarks, like stop bursts, onset of F2, nasalization or frication, etc. All control items and filler words were processed and resynthesized by STRAIGHT to ensure a consistent quality across stimulus items.

Pretest

To determine which step of each continua would be used in exposure, a phonetic categorization experiment was conducted. Participants were presented with each step of each exposure word-nonword continuum and each categorization minimal pair continuum, resulting in 495 trials (40 exposure words plus five minimals pairs

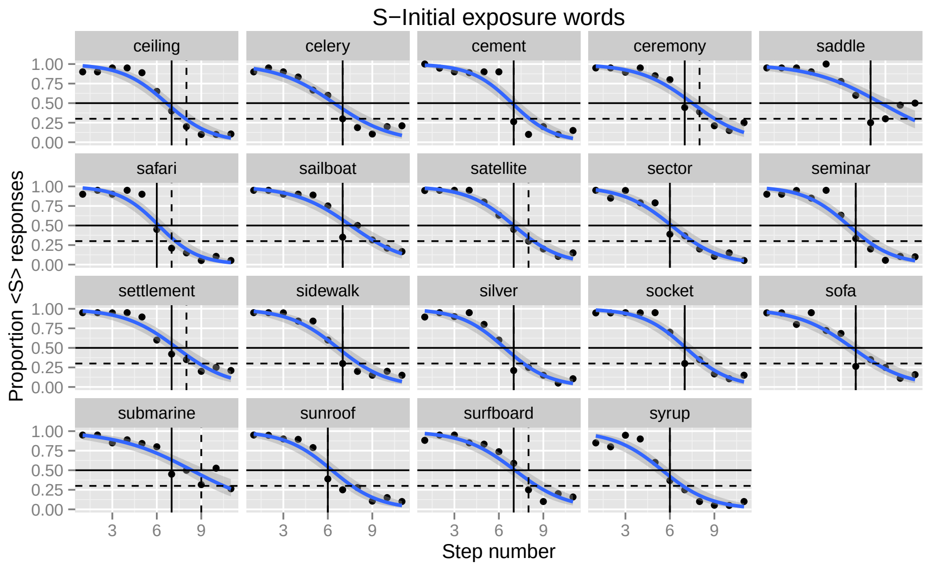

Figure 3.1: Proportion of word-responses for /s/-initial exposure words. Solid lines represent Experiment 1 selection criteria (50% word-response rate) and dashed lines represent Experiment 2 selection criteria (30% word-response rate). Dots are averaged word-response across subjects, and the blue line is a binomial model constructed from the responses.

by 11 steps). The experiment was implemented in E-prime (cite). As half of the critical items had a sibilant in the middle of the word (onset of the final syllable), participants were asked to respond with word or non word rather than asking for the identity of the ambiguous sound, as in previous research [7].

The proportion of s-responses (or word responses for exposure items) at each step of each continuum was calculated and the most ambiguous step chosen. The threshold for the ambiguous step for this experiment was when the percentage of s-response dropped near 50%. A full list of steps chosen for each stimulus item is in the appendix. For the minimal pairs, six steps surrounding the 50% cross over point were selected for use in the phonetic categorization task. Due to experimenter error, the continuum for *seedling* was not included in the stimuli, so the chosen step was the average chosen step for the /s/-initial words. The average step chosen for

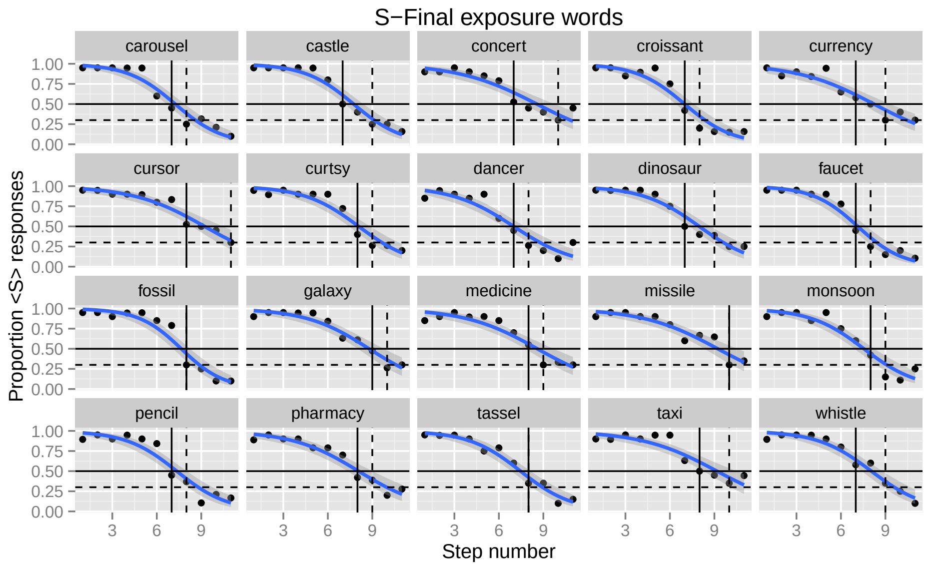

Figure 3.2: Proportion of word-responses for /s/-final exposure words. Solid lines represent Experiment 1 selection criteria (50% word-response rate) and dashed lines represent Experiment 2 selection criteria (30% word-response rate). Dots are averaged word-response across subjects, and the blue line is a binomial model constructed from the responses

/s/-initial words was 6.8 ($SD = 0.5$), and for /s/-final words the average step was 7.7 ($SD = 0.8$).

Procedure

Participants in the experimental conditions completed two tasks, an exposure task and a categorization task. The exposure task was a lexical decision task, where participants heard auditory stimuli and were instructed to respond with either ”word” if they thought what they heard was a word or ”nonword” if they didn’t think it was a word. The buttons corresponding to ”word” and ”nonword” were counterbalanced across participants. Trial order was pseudorandom, with no critical or control items appearing in the first six trials, and no critical or control trials in a row, but random otherwise, following (ReinischWeberMitter2012).

In the categorization task, participants heard an auditory stimulus and had to categorize it as one of two words, differing only in the onset sibilant (s vs sh). The buttons corresponding to the words were counterbalanced across participants. The six most ambiguous steps of the minimal pair continua were used with seven repetitions each, giving a total of 168 trials. Participants were instructed that there would two tasks in the experiment, and both tasks were explained at the beginning to remove experimenter interaction between exposure and categorization.

Participants were assigned to one of four conditions. Two of the conditions exposed participants to only criticall items that began with /s/, and the other two exposed them to only critical items that had an /s/ in the onset of the final syllable, giving a consistent 200 trials in all exposure phases with control and filler items shared across all participants. Additionally participants in half the conditions received additional instructions that the speaker's "s" sounds were sometimes ambiguous, and to listen carefully to ensure correct responses in the lexical decision.

3.2.2 Results

3.2.3 Discussion

3.3 Experiment 2

3.3.1 Methodology

This experiment followed an identical methodology as experiment 1, except that the step along the /s/-/sh/ continua chosen as the ambiguous sound had a different threshold. For this experiment, 30% identification as the /s/ word was used the threshold. The average step chosen for /s/-initial words was 7.3 ($SD = 0.8$), and for /s/-final words the average step was 8.9 ($SD = 0.9$).

3.3.2 Results

3.3.3 Discussion

Chapter 4

Cross-modal word identification

4.1 Motivation

4.1.1 Semantic predictability

The type of contextual predictability used in this experiment is known as semantic predictability. Sentences are highly predictable when they contain words prior to the final word that points almost definitively to the identity of the final word. For instance, the sentence fragment *The cow gave birth to the...* from **?**] is almost guaranteed to be completed with the word *calf*. On the other hand, a fragment like *She is glad Jane called about the...* is far from having a guaranteed completion, other than having the category of noun. Semantic predictability has been found to have effects on both production and perception, which will be discussed in the two following sections

Acoustic realization

In general, semantic predictability has a reductive effect on the acoustics of words. In **?**], words produced in highly predictable frames tend to be shorter in duration and have less dispersed vowel realizations. This semantic predictability effect did not interact with neighbourhood density, a lexical factor that proxies for the amount of lexical competition a word has. Words with many neighbours, and therefore had lessened lexical predictability, had longer durations and more dispersed vowel realizations. For both the lexical and the semantic predictability, high predictability led to less distinct word realizations, and low predictability led to more distinct word realizations, independently of each other.

In a study looking at semantic predictability across dialects, **?**] found that not all dialects realize the effects of semantic predictability the same. For the Southern dialect of American English, the results were much the same as in **?**], showing temporal and spectral reduction in high predictabilty environments. However, speakers in the Midland dialect showed no such effect, and speakers of the Northern dialect showed more extreme Northen Cities shifting in the the high predictability environment.

Intelligibility

Despite the temporal and spectral reduction found in high predictability contexts, high predictability sentences are generally more intelligible. Sentences that form a semantically coherent whole have higher word identification rates across varying signal-to-noise ratios [**?**]. However, when words at the ends of predictive sentences are excised from their context, they tend to be less intelligible than words excised from non-predictive contexts [**?**]. ¡¡I don't know if this is just due to differences in speaking rates/durations. Do you know of any studies (maybe based on sentences excised from sponataneous speech) where words would be said with similar durations or have contextual frames that normalize the duration differences for the listener?¿¿

4.1.2 Similarity to lexical bias

A key pillar of the motivation underlying this experiment is the notion that semantic predictability is similar to, yet distinct from, lexical bias/lexical predictability. **?**] found that lexical predictability and semantic predictability did not interact and had the same effect directions, but different effect sizes, with lexical predictability having a larger effect than semantic predictability.

One line of research has attempted to show whether the semantic predictability effects are part of perceptual and phonetic processing or if they result following phonetic processing. **?**] established different reaction time profiles for perceptual and postperceptual processes in categorizing a continuum. With lexical bias, response times to the end points of a /d/ to /t/ continuum show no difference whether the continuum forms a word at one end point (such as *dice* to *tice*) or at the other (such as *dype* to *type*). However, at the boundary between /d/ and /t/, reaction times are faster when a subject responds consisten to the bias (i.e. interprets an ambiguous word *?ice* as *dice*). For postperceptual processes, in this case a monetary payoff for responding either /d/ or /t/ along a continuum that has nonwords at both ends, the pattern is reversed, where reaction times were faster for responses consistent with the monetary bias at the end points of the continuum, but no such difference was found for the category boundary. Both biases produced similar categorization patterns, such that the participants biased toward /d/, either lexically or monetarily, categorized more of the continuum as /d/, so the principle difference between the two biases was in the reaction time profile.

Two studies that have looked at semantic predictability in this paradigm are **?**] and **?**], and they found conflicting results. In **?**], the reaction time profile aligned more with the monetary bias in **?**], with reaction time differences located at the end point and not the category boundary, but **?**] found the reverse with a profile more similar to lexical bias. ¡¡Examine differences between studies¿¿

4.1.3 Attention?

I don't know of any work that has specifically looked at attention (to acoustics in particular) in the context of semantic predictability.

4.2 Methodology

4.2.1 Participants

One hundred native speakers of English (mean age ??, range ??-??) participated in the experiment and were compensated with either $10 CAD or course credit. They were recruited from the UBC student population. Twenty additional native English speakers participated in a pretest to determine sentence predictability, and 10 other native English speakers participated in a picture naming pretest.

Participants were assigned to one of four groups of 25 participants. In the exposure phase, half of the participants were exposed to a modified /s/ sound only in Predictive sentences and half were exposed to it only in Unpredictive sentences. Half of all participants were told that the speaker's production of "s" was somtimes ambiguous, and to listen carefully to ensure correct responses. Participants were native North American English speakers with no reported speech or hearing disorders.

4.2.2 Materials

One hundred and twenty sentences were used as exposure materials. The set of sentences consisted of 40 critical sentences, 20 control sentences and 60 filler sentences. The critical sentences ended in one of 20 of the critical words in Experiments 1 and 2 that had an /s/ in the onset of the final syllable. The 20 control sentences ended in the 20 control items used in Experiments 1 and 2, and the 60 filler sentences ended in the 60 filler words in Experiments 1 and 2. Half of all sentences were written to be predictive of the final word, and the other half were written to be unpredictive of the final word. Unlike previous studies using sentence or semantic predictability (Kalikow), Unpredictive sentences were written with the final word in mind with a variety of sentence structures, and the final words were plausible objects of lexical verbs and prepositions. A full list of words and their contexts can be found in the appendix. Aside from the sibilants in the critical and control words, the sentences contained no sibilants (/s z sh zh ch jh/). The same minimal pairs for phonetic categorization as in Experiments 1 and 2 were used.

Sentences were recorded by the same male Vancouver English speaker used in Experiments 1 and 2. Critical sentences were recorded in pairs, with one normal production and then a production of the same sentence with the /s/ in the final word replaced with an /sh/. The speaker was instructed to produce both sentences with comparable speech rate, speech style and prosody.

As in Experiments 1 and 2, the critical items were morphed together into an 11-step continuum using STRAIGHT (cite); however, only the final word in sentence was morphed. For all steps, the preceding words in the sentence were kept as the natural production to minimize artifacts of the morphing algorithm. As in

Experiments 1 and 2, the control and filler items were processed and resynthesized. The ambiguous point selection was based on the pretest performed for Experiment 1 and 2 exposure items. The ambiguous steps of the continua chosen corresponded to the 50% cross over point in Experiment 2.

Pictures of 200 words, with 100 pictures for the final word of the sentences and 100 for distractors, were selected in two steps. First, a research assistant selected five images from a Google image search of the word, and then a single image representing that word was selected from amongst the five by me. To ensure consistent behaviour in E-Prime, pictures were resized to fit within a 400x400 area with a resolution of 72x72 DPI and converted to bitmap format. Additionally, any transparent backgrounds in the pictures were converted to plain white backgrounds.

4.2.3 Pretest

The same twenty participants that completed the lexical decision continua pre-test also completed a sentence predictability task before the phonetic categorization task described in Experiment 1. Participants were compensated with $10 CAD for both tasks, and were native North American English speakers with no reported speech, language or hearing disorders. In this task, participants were presented with sentence fragments that were lacking in the final word. They were instructed to type in the word that came to mind when reading the fragment, and to enter any additional words that came to mind that would also complete the sentence. There was no time limit for entry and participants were shown an example with the fragment "The boat sailed across the..." and the possible completions "bay, ocean, lake, river". Responses were collected in E-Prime (cite), and were sanitized by removing miscellaneous keystrokes recorded by E-Prime, spell checking, and standardizing variant spellings and plural forms.

The measure used for determining rewriting of sentences was the proportion of participants that included the target word in their responses. For predictive sentences, the mean proportion was 0.49 (range 0-0.95) and for unpredictive sentences, the mean proportion was 0.03 (range 0-0.45). Predictive sentences that had target response proportions of 20% or less were rewritten. The predictive sentences for *auction*, *brochure*, *carousel*, *cashier*, *cockpit*, *concert*, *cowboy*, *currency*, *cursor*, *cushion*, *dryer*, *graffiti*, and *missile* were rewritten to remove any ambiguities.

Five volunteers from the Speech in Context lab participated in another pretest to determine how suitable the pictures were at representing their associated word. All participants were native speakers of North American English, with reported corrected-to-normal vision. Participants were presented with a single image in the middle of the screen. Their task was to type the word that first came to mind, and any other words that described the picture equally well. There was no time limit and presentation of the pictures was self-paced. Responses were sanitized as in the first pretest.

Pictures were replaced if 20% or less of the participants (1 of 5) responded with the target word and the responses were semantically unrelated to the target word. Five pictures were replaced, *toothpick* and *falafel* with clearer pictures and *ukulele*, *earmuff* and *earplug* were replaced with *rollerblader*, *anchor* and *bedroom*. All five replacements were for distractor words.

4.2.4 Procedure

As in Experiments 1 and 2, participants completed two tasks, an exposure task and a categorization task. For the exposure task, participants heard a sentence via headphones for each trial. Immediately following the auditory presentation, they were presented with two pictures on the screen. Their task was to select the picture on the screen that corresponded to the final word in the sentence they heard. As in Experiments 1 and 2, the order was pseudorandom, with the same constraints.

Following the exposure task, participants completed the same categorization task described in Experiments 1 and 2.

4.3 Results

4.4 Discussion

Chapter 5

Conclusions

Stuff I have concluded

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