
Practical optimal experiment design for psychology

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Abstract

The abstract paragraph should be indented $\frac{1}{2}$ inch (3 picas) on both the left- and right-hand margins. Use 10 point type, with a vertical spacing (leading) of 11 points. The word **Abstract** must be centered, bold, and in point size 12. Two line spaces precede the abstract. The abstract must be limited to one paragraph.

1 Introduction

- It is difficult to discriminate models of psychological processes
- Experiments are expensive
- We present a general, turn-key approach to design experiments that best disambiguate competing models using a Bayesian framework
- This technique is not directly related to Bayesian models of cognition. It can be used on any (formal / probabilistic) model, including Bayesian models of cognition
- Despite the previous attempts in this field, there are a number of pragmatic issues that make it difficult to readily apply OED techniques for psychology, including:
 - A variety of proposed optimization criteria, which puts the burden on researchers to have sufficient expertise to select the appropriate approach
 - A lack of an established pipeline, requiring researchers to develop a language to formalize psychological models and write an OED optimization engine
 - A lack of analysis in dealing with practical experimental concerns such as:
 - * Noisy responses from participants
 - * The ideal number of participants for a study
 - * The ambiguity of linking functions of dependent measures

2 Bayesian model selection framework

3 Case study 1: Subjective randomness

4 Case study 2: Category learning

5 Relationship to previous work

26 5.1 Retrieval of style files

27 The style files for NIPS and other conference information are available on the World Wide Web at

28 <http://www.nips.cc/>

29 The file `nips_2016.pdf` contains these instructions and illustrates the various formatting require-
30 ments your NIPS paper must satisfy.

31 The only supported style file for NIPS 2016 is `nips_2016.sty`, rewritten for L^AT_EX 2_ε. **Previous**
32 **style files for L^AT_EX 2.09, Microsoft Word, and RTF are no longer supported!**

33 The new L^AT_EX style file contains two optional arguments: `final`, which creates a camera-ready copy,
34 and `nonatbib`, which will not load the `natbib` package for you in case of package clash.

35 At submission time, please omit the `final` option. This will anonymize your submission and add
36 line numbers to aid review. Please do *not* refer to these line numbers in your paper as they will be
37 removed during generation of camera-ready copies.

38 The file `nips_2016.tex` may be used as a “shell” for writing your paper. All you have to do is
39 replace the author, title, abstract, and text of the paper with your own.

40 The formatting instructions contained in these style files are summarized in Sections 6, 7, and 8
41 below.

42 6 General formatting instructions

43 The text must be confined within a rectangle 5.5 inches (33 picas) wide and 9 inches (54 picas) long.
44 The left margin is 1.5 inch (9 picas). Use 10 point type with a vertical spacing (leading) of 11 points.
45 Times New Roman is the preferred typeface throughout, and will be selected for you by default.
46 Paragraphs are separated by ½ line space (5.5 points), with no indentation.

47 The paper title should be 17 point, initial caps/lower case, bold, centered between two horizontal
48 rules. The top rule should be 4 points thick and the bottom rule should be 1 point thick. Allow ¼ inch
49 space above and below the title to rules. All pages should start at 1 inch (6 picas) from the top of the
50 page.

51 For the final version, authors’ names are set in boldface, and each name is centered above the
52 corresponding address. The lead author’s name is to be listed first (left-most), and the co-authors’
53 names (if different address) are set to follow. If there is only one co-author, list both author and
54 co-author side by side.

55 Please pay special attention to the instructions in Section 8 regarding figures, tables, acknowledgments,
56 and references.

57 7 Headings: first level

58 All headings should be lower case (except for first word and proper nouns), flush left, and bold.

59 First-level headings should be in 12-point type.

60 7.1 Headings: second level

61 Second-level headings should be in 10-point type.

62 7.1.1 Headings: third level

63 Third-level headings should be in 10-point type.

64 **Paragraphs** There is also a `\paragraph` command available, which sets the heading in bold, flush
65 left, and inline with the text, with the heading followed by 1 em of space.

66 8 Citations, figures, tables, references

67 These instructions apply to everyone.

68 8.1 Citations within the text

69 The natbib package will be loaded for you by default. Citations may be author/year or numeric, as
70 long as you maintain internal consistency. As to the format of the references themselves, any style is
71 acceptable as long as it is used consistently.

72 The documentation for natbib may be found at

73 `http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf`

74 Of note is the command `\citet`, which produces citations appropriate for use in inline text. For
75 example,

76 `\citet{hasselmo}` investigated\dotso

77 produces

78 Hasselmo, et al. (1995) investigated...

79 If you wish to load the natbib package with options, you may add the following before loading the
80 nips_2016 package:

81 `\PassOptionsToPackage{options}{natbib}`

82 If natbib clashes with another package you load, you can add the optional argument nonatbib
83 when loading the style file:

84 `\usepackage[nonatbib]{nips_2016}`

85 As submission is double blind, refer to your own published work in the third person. That is, use “In
86 the previous work of Jones et al. [4],” not “In our previous work [4].” If you cite your other papers
87 that are not widely available (e.g., a journal paper under review), use anonymous author names in the
88 citation, e.g., an author of the form “A. Anonymous.”

89 8.2 Footnotes

90 Footnotes should be used sparingly. If you do require a footnote, indicate footnotes with a number¹
91 in the text. Place the footnotes at the bottom of the page on which they appear. Precede the footnote
92 with a horizontal rule of 2 inches (12 picas).

93 Note that footnotes are properly typeset *after* punctuation marks.²

94 8.3 Figures

95 All artwork must be neat, clean, and legible. Lines should be dark enough for purposes of reproduction.
96 The figure number and caption always appear after the figure. Place one line space before the figure
97 caption and one line space after the figure. The figure caption should be lower case (except for first
98 word and proper nouns); figures are numbered consecutively.

99 You may use color figures. However, it is best for the figure captions and the paper body to be legible
100 if the paper is printed in either black/white or in color.

101 8.4 Tables

102 All tables must be centered, neat, clean and legible. The table number and title always appear before
103 the table. See Table 1.

¹Sample of the first footnote.

²As in this example.



Figure 1: Sample figure caption.

Table 1: Sample table title

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	~ 100
Axon	Output terminal	~ 10
Soma	Cell body	up to 10^6

Place one line space before the table title, one line space after the table title, and one line space after the table. The table title must be lower case (except for first word and proper nouns); tables are numbered consecutively.

Note that publication-quality tables *do not contain vertical rules*. We strongly suggest the use of the booktabs package, which allows for typesetting high-quality, professional tables:

<https://www.ctan.org/pkg/booktabs>

This package was used to typeset Table 1.

9 Final instructions

Do not change any aspects of the formatting parameters in the style files. In particular, do not modify the width or length of the rectangle the text should fit into, and do not change font sizes (except perhaps in the **References** section; see below). Please note that pages should be numbered.

10 Preparing PDF files

Please prepare submission files with paper size “US Letter,” and not, for example, “A4.”

Fonts were the main cause of problems in the past years. Your PDF file must only contain Type 1 or Embedded TrueType fonts. Here are a few instructions to achieve this.

- You should directly generate PDF files using `pdflatex`.
- You can check which fonts a PDF files uses. In Acrobat Reader, select the menu Files>Document Properties>Fonts and select Show All Fonts. You can also use the program `pdf fonts` which comes with `xpdf` and is available out-of-the-box on most Linux machines.
- The IEEE has recommendations for generating PDF files whose fonts are also acceptable for NIPS. Please see <http://www.emfield.org/icuwb2010/downloads/IEEE-PDF-SpecV32.pdf>
- `xfig` “patterned” shapes are implemented with bitmap fonts. Use “solid” shapes instead.
- The `\bbold` package almost always uses bitmap fonts. You should use the equivalent AMS Fonts:

129 `\usepackage{amsfonts}`
 130 followed by, e.g., `\mathbb{R}`, `\mathbb{N}`, or `\mathbb{C}` for \mathbb{R} , \mathbb{N} or \mathbb{C} . You can also
 131 use the following workaround for reals, natural and complex:

132 `\newcommand{\RR}{I\!\!R} %real numbers`
 133 `\newcommand{\Nat}{I\!\!N} %natural numbers`
 134 `\newcommand{\CC}{I\!\!C} %complex numbers`

135 Note that `amsfonts` is automatically loaded by the `amssymb` package.

136 If your file contains type 3 fonts or non embedded TrueType fonts, we will ask you to fix it.

137 10.1 Margins in L^AT_EX

138 Most of the margin problems come from figures positioned by hand using `\special` or other
 139 commands. We suggest using the command `\includegraphics` from the `graphicx` package.
 140 Always specify the figure width as a multiple of the line width as in the example below:

141 `\usepackage[pdftex]{graphicx} ...`
 142 `\includegraphics[width=0.8\linewidth]{myfile.pdf}`

143 See Section 4.4 in the graphics bundle documentation ([http://mirrors.ctan.org/macros/](http://mirrors.ctan.org/macros/latex/required/graphics/grfguide.pdf)
 144 [latex/required/graphics/grfguide.pdf](http://mirrors.ctan.org/macros/latex/required/graphics/grfguide.pdf))

145 A number of width problems arise when L^AT_EX cannot properly hyphenate a line. Please give LaTeX
 146 hyphenation hints using the `\-` command when necessary.

147 Acknowledgments

148 Use unnumbered third level headings for the acknowledgments. All acknowledgments go at the end
 149 of the paper. Do not include acknowledgments in the anonymized submission, only in the final paper.

150 References

151 References follow the acknowledgments. Use unnumbered first-level heading for the references. Any
 152 choice of citation style is acceptable as long as you are consistent. It is permissible to reduce the font
 153 size to `small` (9 point) when listing the references. **Remember that you can use a ninth page as**
 154 **long as it contains *only* cited references.**

155 [1] Alexander, J.A. & Mozer, M.C. (1995) Template-based algorithms for connectionist rule extraction. In
 156 G. Tesauro, D.S. Touretzky and T.K. Leen (eds.), *Advances in Neural Information Processing Systems 7*, pp.
 157 609–616. Cambridge, MA: MIT Press.

158 [2] Bower, J.M. & Beeman, D. (1995) *The Book of GENESIS: Exploring Realistic Neural Models with the*
 159 *GEneral NEural Simulation System*. New York: TELOS/Springer-Verlag.

160 [3] Hasselmo, M.E., Schnell, E. & Barkai, E. (1995) Dynamics of learning and recall at excitatory recurrent
 161 synapses and cholinergic modulation in rat hippocampal region CA3. *Journal of Neuroscience* **15**(7):5249-5262.