LAB: Linguistic Annotated Bibliography – A searchable portal for normed database information

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Abstract

In the era of big data, psycholinguistic research is flourishing with numerous publications advancing our knowledge of word characteristics and ways to study them. This article presents the Linguistic Annotated Bibliography (LAB) as a searchable web portal to quickly and easily access reliable database norms, related programs, and variable calculations. These publications (N = 561) were coded by language, number of stimuli, stimuli type (i.e. words, pictures, symbols), keywords (i.e. frequency, semantics, valence), and other useful information. This tool not only allows researchers to search for the specific type of stimuli needed for experiments, but also permits the exploration of publication trends across 100 years of research. Details about the portal creation and use are outlined, as well as various analyses of change in publication rates and keywords. In general, advances in computation power have allowed for the increase in dataset size in the recent decades, in addition to an increase in the number of linguistic variables provided in each publication.

Keywords: database, stimuli, online portal, megastudy, trends

Word count: X

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The advance of computational ability and the Internet have propelled research into an era of so-called big data that have interesting implications for the field of psycholinguistics, as well as other experimental areas that use normed stimuli for their research. Traditionally, stimuli used for experimental research in psycholinguistics were first examined through small pilot studies that were then used in many subsequent projects. While economic, that selection procedure's results could be potentially misleading as a factor of the stimuli, rather than experimental manipulation. This limitation can potentially be tied to a lack of funding, time, computing power, or even interest in studying phenomena at the stimuli level. Now, we have the capability to collect, analyze, and publish large datasets for research into memory models (Cree, McRae, & McNorgan, 1999; Moss, Tyler, & Devlin, 2002; Rogers & McClelland, 2004; Vigliocco, Vinson, Lewis, & Garrett, 2004), aphasias (Vinson, Vigliocco, Cappa, & Siri, 2003), probability and linguistics (Cree & McRae, 2003; McRae, De Sa, & Seidenberg, 1997; Pexman, Holyk, & Monfils, 2003), valence (Dodds, Harris, Kloumann, Bliss, & Danforth, 2011; Vo et al., 2009; Warriner, Kuperman, & Brysbaert, 2013), and reading speeds and priming (Balota et al., 2007; Cohen-Shikora, Balota, Kapuria, & Yap, 2013; Hutchison et al., 2013; Keuleers, Lacey, Rastle, & Brysbaert, 2012) to name a small subset of research avenues. Big data has manifested in psycholinguistics over the last decade in the form of grant funded megastudies to collect and analyze large text corpora (the SUBTLEX projects) or to examine numerous word properties in one study (the Lexicon projects). The SUBTLEX projects were designed to analyze frequency counts for concepts across extremely large corpora sizes using subtitles as a substitute for natural speech. The investigation of these measures was first spurred by the realization that word frequency is an important predictor of naming and lexical decision times (Balota, Cortese, Sergent-Marshall, Spieler, & Yap, 2004; Rayner & Duffy, 1986). While previous measures of frequency (i.e. Baayen, Piepenbrock, Gulikers, & Linguistic Data Consortium, n.d.; Burgess & Livesay, 1998; Kucera & Francis, 1967) were based on large 1 million + word corpora, they were poor predictors of reaction times (Balota et al., 2004; Brysbaert & New, 2009; Zevin & Seidenberg, 2002). Further, it appears from Brysbaert and New (2009)'s investigation into corpora size and type, that not only should the corpora be large (>16 million), but the underlying source of the text data matters (Internet versus subtitles), as well as the contextual diversity of the data (i.e. number of occurrences across sources; Adelman, Brown, & Quesada, 2006). Not only has their work (Brysbaert & New, 2009) been included in newer lexical studies (Hutchison et al., 2013; Yap, Tan, Pexman, & Hargreaves, 2011), but SUBTLEX projects have been published in Dutch (Keuleers, Brysbaert, & New, 2010), Greek [Dimitropoulou2010], Spanish (Cuetos, Glez-Nosti, Barbon, & Brysbaert, 2011), Chinese (Cai & Brysbaert, 2010), French (New, Brysbaert, Veronis, & Pallier, 2007), British English (Heuven, Mandera, Keuleers, & Brysbaert, 2014), and German (Brysbaert et al., 2011). The Lexicon projects created large databases of validated mono- and multisyllabic words to assist in the creation of controlled experimental stimuli sets for future experiments. These databases contain lexical decision and naming response times, as well as typical word confound variables such as orthographic neighborhood, phonological and morphological characteristics. While the English Lexicon Project (Balota et al., 2007) is the most cited of the lexicons, other languages include Chinese (Sze, Rickard Liow, & Yap, 2014), Malay (Yap, Rickard Liow, Jalil, & Faizal, 2010), Dutch (Keuleers et al., 2010), and British English (Keuleers et al., 2012). Another twenty or so similar lexical database publications can be found in the literature covering French (Lété & Sprenger-Charolles, 2004), Italian (Barca, Burani, & Arduino, 2002), Arabic (Boudelaa & Marslen-Wilson, 2010), and Portuguese (Soares et al., 2014). The availability of big data has augmented the psycholinguistic literature, but these projects are certainly time consuming due to the amount of participant data required to achieve reliable and stable norms. The solution potentially lies in several avenues of easily obtainable data. First, Amazon's Mechanical Turk, an online crowdsourcing avenue that allows researchers to pay users to complete questionnaires, has shown to be a reliable, diverse participant pool made available at very low cost (Buhrmester et al., 2011; Mason & Suri, 2012). Researchers can pre-screen for specific populations, as well as post-screen surveys for incomplete or inappropriate responses, thus saving time and money with the elimination of poor data. Because of the popularity of Mechanical Turk, large amounts of data can be collected in shorter time periods than traditional experiments. Mechanical Turk has been used to collect data for semantic word pair norms (Buchanan, Holmes, Teasley, & Hutchison, 2013), age of acquisition ratings (Kuperman, Stadthagen-Gonzalez, & Brysbaert, 2012), concreteness ratings (Brysbaert, Warriner, & Kuperman, 2014), past tense information (Cohen-Shikora et al., 2013), and valence and arousal ratings (Dodds et al., 2011; Jasmin & Casasanto, 2012; Warriner et al., 2013). Additionally, in a similar vein to the SUBTLEX projects, linguistic data has been mined from open source data, such as the New York Times, music lyrics, and Twitter (Dodds et al., 2011; Kloumann, Danforth, Harris, Bliss, & Dodds, 2012). Finally, De Deyne, Navarro, and Storms (2013) have seen success in simply setting up a special website (www.smallworldofwords.com) to collect word pair association norms. The evolution of big data provides exciting opportunities for exploration into psycholinguistics, and this article features the trends in publications of normed datasets across the literature allowing for a large-scale picture of the developments of trends in psychological stimuli. Historically, these norms have been published in journals connected to the Psychonomic Society, such as Behavior Research Methods, Psychonomic Monograph Supplements, and Perception and Psychophysics. The society once hosted an electronic database that contained the links to these norms, as well as a search tool to find information about previously published works (Vaughan, 2004). The sale of the society journals to Springer publications has improved journal visibility and user-friendly access, but also has left a need for an indexed list of database publications that span multiple keywords and journal websites. Therefore, the purpose of this article is twofold: 1) to present a searchable, cataloged database of normed stimuli and related materials for a wide range of experimental research, and 2) to examine trends in the publications of these articles to assess the big data movement within psycholinguistics. #Website Readers can find the website by going to the host site for semantic word pair norms Buchanan et al. (2013) at http://www.wordnorms.com or by going to the direct link at http://wordnorms.missouristate.edu. The wordnorms.com website will redirect you to the direct link and was meant to be an easier web address to remember, in addition to a permanent address in case of a change in hosting university. From this page, the top navigation bar includes a link for Norms to direct the reader to the LAB page. The main LAB page, as shown in Figure 1 includes the purpose statement, and several website options. From here, users can suggest articles that should be included in the dataset by clicking on Enter data here, view all the data in an easy to copy format (View all data big) or in a smaller more readable format (View all data small), search the database with large, easy to copy table (Search with large data output) or small table formats (Search with small data output) and view many of the tables presented here. These tables are dynamic, and they update with each addition to the database, which allows the user to view current statistics even after publication. Although the website was designed to be intuitively user friendly, a complete how-to guide is included online for unfamiliar users. Specific features will be outlined below in relation to the database creation.

Database

Methods

Materials

Bradshaw (1984) and Proctor and Kim-Phuong (1999)'s lists of database information were used as starting points for collection of research articles. We searched Academic Search Premier, PsycInfo, and ERIC through the EBSCO host system, as well as Google scholar to find other relevant articles using the following keywords: corpus, linguistic database, linguistic norms, norms, and database. Additionally, since many of the original articles were hosted by the Psychonomic Society, the Springer website was searched with these terms that covered the newer editions of Behavior Research Methods and Memory & Cognition. We then filtered for articles that met the following criteria: 1) contained database information as supplemental material, 2) demonstrated programs related to building research stimuli using normed databases, or 3) generated new calculations of lexical variables. Research articles that used normed databases in experimental design or tested those variables validity/reliability were excluded if they did not include new database information. Additional articles were found while coding initial publications by searching citations for stimuli selection. For example, the Snodgrass and Vanderwart (1980) norms were cited in many newer articles on line drawings, and therefore this article was subsequently entered into the database. At the time of writing, 561 articles, books, websites and technical reports were included in the following analyses. ##Coding Procedure The tables with summaries from Bradshaw (1984) and Proctor and Kim-Phuong (1999) were consulting for a starting point for data coding. Then, the first round of articles found (approximately 100) from the methods described above were analyzed to determine information that would be pertinent to a user who wished to search for normed stimuli. Based on these reviews and lab discussions, we coded the following information from each article: 1) journal information, 2) stimuli types, 3) stimuli language, 4) programs or corpus name, 5) keywords, which we refer to as tags, 6) special populations, and 7) other notes that did not fit into those categories. Each piece of information is detailed below. In some instances, codes were not used as frequently as expected based on these initial discussions, but were included to allow more specificity in searching, as well as the flexibility to include those options for articles subsequently added to the database. ###Journal Information Each article was coded with the citation information, and a complete list of citations can be found on the website portal by clicking on view all data. All author last names are listed, along with publication year, article title, journal title, volume, page numbers, and digital object identifier (DOI) when available. This information is listed in citation format in the small table output, and separated into columns in the large table output for easier sorting and searching. For newer articles that have been published online first without volume or page numbers, X and XX-XX are used as placeholders until official publication. DOIs in all table outputs are hyperlinked to the article on the publication journal's website, which is accessible if the user has access through their membership with a professional organization or university. Although APA style dictates et al. for references after the second author or immediately for large author publications, all names were included each time they were referenced (see below). The inclusion of these names allows a user to search for specific researchers, as well as separates different publications by the same first author. A complete list of publication sources, number of times cited, and percentages can be found online by clicking Journal Frequency Table. ###Stimuli Types While this publication was originally intended for linguistic database norms, other types of experimental stimuli were apparent after background review. Therefore, stimuli were coded based on the dominant description from the article (i.e. although heteronyms are words and word pairs, they were coded specifically as heteronyms). The number of stimuli presented in the appendix or database was coded with the stimuli, unless the article covered specific programs, search or experimental creation tools (the majority of the other category). Because many articles included two types of stimuli, or references to different articles where stimuli were selected from, two options for stimuli were included. Therefore, the total values for number of stimuli do not add up to the number of articles in the database because of multiple instances in articles. Table 1 includes a stimuli list, the number of times that each stimuli was used, percentage of the total stimuli codes, the mean and standard deviation of the number of those stimuli, minimum/maximum values, and a brief variable description. Researchers often cited specific previous works where stimuli were selected from, and these references were included in the stimuli column. Further, if stimuli were associated with a specific database (such as CELEX: Baayen et al., n.d. and ANEW: Bradley and Lang (1999)), those abbreviations were included for searching capabilities. Table 1 is included dynamically online, such that updates are included automatically, and can be found under the Stimuli Frequency Table link. ###Stimuli Language The language of the stimuli set was coded by starting with the most common languages from the first articles surveyed, and others were added as it was apparent that several norms were present for that language (such as Japanese, Dutch, and Greek). If the stimuli were non- linguistic selections, like pictures and line drawings, the language of the participants used to norm the set was used, which was commonly English. The other category was used for low-frequency languages, as well as a multiple category for datasets with more than one set of language norms. One potential limitation of the LAB was that English is the first language for the authors; however, translation tools were used to code sources found in other languages. The LAB portal includes options to report errors in coding, as well as a form to enter new articles that may have been missed due to this drawback. Table 2 shows language frequencies and percentages, and the online version can be found by clicking the Language Frequency Table link. ###Program/corpus name In many instances, megastudies are often named, such as the English Lexicon Project (Balota et al., 2007), for easier reference. This information was included in the in the dataset, which will also help researchers with the stimuli references as described above. For example, a newer study may reference using the BOSS database (Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010), and having that information would make searching for the original article easier by using the corpus name column (especially in instances the dataset name is not listed in the article title). The names of programs or tools were also entered, such as NIM (Guasch, Boada, Ferré, & Sánchez-Casas, 2013), a new stimuli selection tool for psycholinguistic studies. ###Tags Keyword tags are the majority of the database, as they allow for the best understanding of trends and availability of stimuli. Table 3 shows a list of tags, frequencies, percentages, descriptions, and correlations (described below). Each article was coded with tags based on the description of the accessible data, so that one article may have many tags. However, due to the cumulative nature of database research, this tagging system does not mean that each article collected that particular type of data. The most common example of this distinction occurs when data is combined across sources, but presented in a new article. The Maki, McKinley, and

Thompson (2004) semantic distance norms also included values from the South Florida Free Association norms (Nelson, McEvoy, & Schreiber, 2004), and Latent Semantic Analysis (Landauer & Dumais, 1997). Therefore, this article was coded with association and semantics, even though the association norms were not collected in that paper. As described above, some small frequency tags were used because of the initial pass through newer articles, but these were left in the database because of their specificity, and they can be used in future additions. ###Special Populations While coding articles, it became apparent that a subset of the normed data was tested on specific special populations. Consequently, demographic data such as gender, age, ethnicity, and grade school year were listed as described in the article (i.e. if ages were used, age was listed, but if grade year was used, it was listed rather than translating to specific ages). ###Other/Notes Lastly, places for more description were included for tags or variables not frequently used, which was especially useful for program descriptions, as well as descriptions of specific types of stimuli (i.e. CVC trigrams). In several instances, notes that appeared frequently were moved to tags (such as similarity) after the database had several hundred articles sampled. All information described above without a specific table (special populations, other, program/corpus names, and journal information) can be found by clicking on either the small or large view data links online.

Results and Discussion

Journals. Journal results, unsurprisingly, show that the wealth of data was published in Behavior Research Methods (59.42% combined across name changes). However, a large number of articles also appeared in Psychonomic Monograph Supplements (3.41%), Journal of Verbal Learning and Verbal Behavior (2.69%), Psychonomic Science (2.69%), Journal of Experimental Psychology (combined across subjournals, 2.34%), Perception & Psychophysics (2.33%), Memory & Cognition (2.15%), Bulletin of the Psychonomic Society (1.26%), Norms of Word Association (1.44%; Postman & Keppel, 1970), and a large category of other publications (21.24%). The complete list can be found in the Journal Frequency

Table online, as there were 107 different entries for journals, books, and websites of publications. While some of these sources were not published with peer review (i.e. websites), they were generally found through citations of other peer-reviewed work. Although Behavior Research Methods has dominated the field for publications, the large array of options for publishing indicates a growth in the available avenues for researchers in this field (for example, open source journals such as PLoS ONE and websites). Figure 2 portrays the number of publications in half decade intervals, and there has been a clear expansion of database and program papers, as part of the growth in big data. Interestingly, a first growth of publications tracks with the 1950s cognitive revolution (Miller, 2003), but an odd decline in publications occurred from the 1970s to 1990s. The last twenty years has shown unbelievable progress in this area, at over 121 publications in the last four years alone (2010-2013). This chart can be found in greater detail online, under the Papers Per Year Graph link, showing the ups and downs of publications by year in a larger format. For example, 2004, 2010 and 2013 were big years for linguistic publications, while 2005 and 2006 had smaller numbers of publications. Even with these fluctuations, a clear growth curve in publications can be found since the 90s. ###Stimuli Stimuli are presented in Table 1 with totals, percentages, means (standard deviations), and minimum/maximum values (and online under Stimuli Frequency Table). Naturally, the publication of word norms was over half the dataset (50.55%), which has quite a large range of quantity of stimuli from only ten words to a large corpus of over 500 million words. Other types of word stimuli also appear commonly in the stimuli set such as categories, letters, and word pairs. Because linguistic data was of interest to this publication, we selected publications based on words, and plotted the number of stimuli presented in the paper to examine big data developments. These data were broken down by set size in Figure 3. The upper left hand quadrant shows all stimuli across years, and the big data publications stand out in the last fifteen years of publications. This data was then further broken down into small datasets (<1,000 stimuli; upper right quadrant), medium datasets (1,000 – 500,000 stimuli; bottom left quadrant), and large datasets (500,000 + although there is a large jump between medium and large as most data is either half million or less or a million or more; bottom right quadrant). The small dataset graph shows that these publications are common across time, while the bottom two quadrants are more telling for the megastudies trend investigation. As with languages and tags (below), we see an increase in the number of medium and very large datasets across the years (the lone outlier in the large dataset is the Brown Corpus, Kucera & Francis, 1967). ###Languages The variety and number of languages for stimuli provided an encouraging picture of the growth and diversity of psycholinguistic stimuli, as seen in Table 2. Many articles include multiple languages (4.10%), as well as the inclusion of both Portuguese (1.78%) and Spanish (6.60%), French (5.70%), and even a small number of articles in Greek (0.89%). To examine trends, the English only articles were filtered out of the dataset since they were the majority of publications (63.99%), and were published across all years present in this data. More than half of the papers with multiple languages have been published since 2010 (56.52%). Additionally, the last ten years have seen an explosion of publications in non-English languages (134 publications, 74.81%) with nearly double the number in 2013 (16) than 2012 (9). ###Tags Table 3 displays the number, percentages, correlations of tags across (with?) year, and descriptions of tags (also found online under Tag Frequency Table with N and % values based on any updated numbers). Undoubtedly, these tags represent changes in terminology over time, and some could be combined or recoined. However, even if low frequency ($N < 10$; fourteen tags) tags are excluded, thirty-five different tags were used to describe the types of psycholinguistic data. Many of these tags can be considered individual research areas, and the sizeable number of different options indicates how complex and diverse the field has become since the publication of free association norms in 1910 (Kent & Rosanoff association norms). The total number of tags for each publication was then tallied, and an average number of tags per half decade were plotted in Figure 4 to determine if the number of variables included in a study has grown over time (total tags and year $r = 0.26$, $p = 0.10$). Considering the larger number of publications in the 2000s versus

1950s to 1970s, it appears that the number of keywords for articles is also slowly growing over time. This trend may indicate the evolution in computing possibilities to be able to publish large amounts of data, but also may indicate a desire to combine datasets so that even more stimuli may be considered at once for modeling or experiment creation. Next, tags with at least a sample of 30 publications were investigated individually for trends across time (correlations presented in Table 3, all ps = 0.29-0.40). Individual graphs can be created by clicking on the Tags Per Year Graph link online, which show the total frequency of the selected tag by year. While correlations were not significant, some small positive trends were found, such as the increase in age of acquisition, familiarity, imagery, orthographic neighborhood, syllables, and valence norms. Intriguingly, meaningfulness and association both showed negative correlations, but these correlations can be understood as an artifact of the publication of a book on association norms in the 1970s (Postman & Keppel, 1970), as well as a recent drop off of in the small but steady use of meaningfulness. These small correlations may partially be explained by the sheer number and variation of data available in the LAB portal, as one would expect the number of frequency tags to increase with the recent SUBTLEX publications. Indeed, if the frequency tags are plotted by year an increase across the last decade (22 tags in 2013 alone) can be shown. Readers are encouraged to view the individual graphs for tags to investigate the change of keyword frequency over time, including the rise and demise of several research areas. For example, confusion matrices heyday appears to range from the early 70s to the mid 80s, while arousal norms do not make an appearance until the late 90s. #Conclusion This article had two main purposes: 1) to present the LAB dataset and portal as an annotated bibliography and searchable tool for researchers, and 2) to view trends in psycholinguistic research with an eye toward big data. We believe the LAB website will be a useful channel for all levels of researchers, from graduate students looking for experimental stimuli to design their experiments, to the familiar investigator who wishes to dig deeper into the diverse choices offered. Further, while the majority of publications occur in one particular journal, the LAB allows someone to find articles they may have missed in other areas with the advantage of being collected into one location. User-friendly search tools are provided to aide in searching for specific languages, stimuli, or keywords, as well as multiple outputs for easy copying into Excel or SPSS. With the advent of DOI, links are provided to the original source for a quick transition to the materials provided in that publication. While this article's statistics will become dated with the updates to the LAB, dynamic tables and graphs are provided online to see the current status of the field. Lastly, we encourage users to actively report errors and suggest updates for the LAB dataset as a way to crowd source information that is surely missing, especially in non-English languages. In the introduction, we provided two examples of current megastudies (SUBTLEX and the Lexicon projects), in addition to how researchers might collect big data through Mechanical Turk or Twitter. This article stepped back from looking at individual, large studies or ways to collect data to use the information provided by publications as a window into the fluctuations of the field. Megastudies have become a prevalent topic, but data could have revealed that this popularity was due to recent publication of a small subset of articles. Instead, analyses showed that not only are the numbers of publications accumulating, but the sizes of datasets are also growing in tandem. Megastudies specifically focus on large datasets, but big data can also be indicated here by the divergence in languages available, number of places to publish such data, and the increasing number of keywords for articles across years. Time will tell if these trends can and will continue or if certain areas will see a confusion matrix type decline after many large datasets are published. With the move of traditional lab experiments to smartphone and tablet technology (Dufau et al., 2011), it seems likely that researchers in psycholinguistics will continue to find new and creative ways to modernize the field.

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