

Modeling language change in English first names

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Abstract. Some lexical classes are more susceptible to the effects of sound symbolism, a hypothesized relationship where speech sounds represent non-phonetic properties. Sound symbolic principles are manifested in male and female personal names in English. While previous research found distinct differences between female and male names in English, the current study fills a gap in existing research by adopting a diachronic perspective: male and female names are compared to each other as well as to themselves across time. Statistical analysis was conducted via a generalized additive model in R, using a data of 5600 names sourced from the United States Social Security Administration. The study finds that female names are longer, more likely to end in a vowel, and less likely to have initial primary stress, and that names for both sexes exhibit change over time, shifting towards a pattern previously associated with female names.

Keywords. sound symbolism; onomastics; language change

1. Introduction. This paper examines potential differences in male and female name phonology as they relate to the body of work addressing the linguistic phenomenon of sound symbolism, a proposed non-arbitrary relationship between sound and meaning where speech sounds can represent non-phonetic concepts such as size, shape, or emotion (Kawahara, Noto & Kumagai 2018; Ohala 1997; Sapir 1929; Shih 2020; Uno et al. 2020). The existence of sound symbolism contradicts the principle of arbitrariness, a defining precedent in linguistics stating that there is no connection between the meaning of a word and the sound(s) of a word (Saussure 1916). The goal of the study of sound symbolism is not to disprove the principle of arbitrariness, and proponents of sound symbolism are not arguing that every word has sound-symbolic properties. Rather, the goal of the study of sound symbolism is to provide evidence for the claim that sound symbolism is a characteristic exhibited by select subsets of language.

Using a dataset of 5600 names sourced from the United States Social Security Administration, this study finds that there is a distinct phonological distribution separating female from male names in English. Namely, female names are longer, less likely to have initial primary stress, and less likely to end in a consonant than male names. Section 1 provides a general overview of the body of work on sound symbolism, with a focus specifically on the study of sound symbolism in proper nouns. Section 2 gives an overview of data collection and annotation. Section 3 discusses initial descriptive results. Section 4 motivates and discusses the method of statistical analysis chosen for this dataset. Section 5 presents the quantitative results of the study. Section 6 concludes the paper by discussing current findings and potential directions for future research, including links between naming traditions and trends in culture and immigration.

2. Overview. This section provides an overview of sound symbolism and motivates the need for further investigation of its role in language. First, the historical context of sound symbolism is

* Thanks to Keith Langston, Robin Dodsworth, and the audiences at LSA 2022 and the 7th Annual Linguistics Conference at UGA for their insightful comments and questions. This research was supported by the University of Georgia's Morehead Honors College and Center for Undergraduate Research Opportunities, and the SPARK Award for Undergraduate Research in Linguistics. Authors: Savannah Jane Williams, University of Georgia (savannah.williams@uga.edu) and Margaret E. L. Renwick, University of Georgia (mrenwick@uga.edu).

discussed. After establishing the history of the argument for non-arbitrary linguistic data, we examine potential reasons for the existence of sound symbolism in language by looking at its hypothesized evolutionary roles. We then discuss the forms sound symbolism can take in language, and the functional roles it can play. This section concludes with an overview of the study of sound symbolism in proper nouns and a discussion of research on sex-specific phonology.

2.1. HISTORICAL CONTEXT. The precedent of linguistic arbitrariness comes in large part from Ferdinand de Saussure, who argued that different languages' use of different sounds to express the same meaning proved conclusively that language is entirely arbitrary (1916). Saussure's claim of an arbitrary relationship between the sign and the signified serves as a benchmark observation in a debate that goes back centuries, the beginnings of which were recorded in Plato's dialogue *Cratylus*. In *Cratylus*, Socrates moderates a discussion between Hermogenes and Cratylus, the former of which believes language to be arbitrary, and the latter that there is some relationship between linguistic sign and meaning. Socrates agrees with Hermogenes, citing language's inability to perfectly capture in sound the object or concept it represents.

In their arguments, both Socrates and de Saussure focus on language as a whole, concluding that because the system as a whole is arbitrary so must be its constituent parts. Contrary to this belief, research from multiple fields including linguistics, cognitive science, and anthropology shows that for a small subset of a language the relationship between sound and meaning may not be entirely arbitrary. It may seem like a radical claim in the face of a decades (if not centuries) long precedent of arbitrariness; however, when looking at the potential evolutionary roots of sound symbolism, its intuitiveness becomes evident.

2.2. EVOLUTIONARY ROLES. One of the most basic demonstrations of sound symbolism is seen in intonation patterns. In many languages, a high fundamental frequency (F0) indicates a question, while a low F0 indicates a statement. This relationship has been named the frequency code (Ohala 1997), which posits that a high F0, most often found in the smaller voice boxes of smaller creatures, signifies the deference needed when making a request, while a low F0, found in the larger voice boxes of larger creatures, conveys the authority and confidence needed when making a statement. Not only is this phenomenon cross-linguistic, it is cross-species as well. In many animal species, aggressive vocalizations take the form of a low growl, while surprise or pain is communicated by a high-pitched yelp. It is hypothesized that this association has an evolutionary root, as the ability to use vocalizations to appear either smaller or larger depending on the situation gives animals a great survival advantage (Hinton, Nichols & Ohala 1994). In both human and animal cases, the pitch of the vocalization gives the listener an idea of what the vocalizer might mean.

2.3. SYNESTHETIC SOUND SYMBOLISM. Synesthetic sound symbolism is most widely studied, perhaps due to the novelty of the idea that acoustic sounds can represent non-acoustic properties such as size or shape. Evidence from novel word recognition studies provides insight into the role that synesthetic sound symbolism might play in present day communication. Sapir (1929) concluded that some vowels "sound bigger" than others, namely that the vowel [A] is judged as referring to larger objects, and the vowel [i] as referring to smaller objects. This is evidenced by the use of [i] in English to emphasize smallness, as seen in words like "teeny-tiny" and "mini".

This phenomenon is not unique to English, in fact, Lapolla (1994) demonstrated that there is a cross-linguistic association of acute segments with words connoting smallness, and grave segments with words connoting largeness, where native English speakers and native Chinese speakers displayed similar sensitivity to sound symbolism. Sound-shape correspondence has

been shown as well, in a phenomenon known as the “bouba-kiki” effect. Participants are more likely to pair pseudowords containing the velar plosive [k] with spiky shapes, and the bilabial plosive [b] with round shapes (Köhler 1929). D’Onofrio (2013) expanded on previous research by isolating potential variables such as vowel quality and consonant place of articulation, allowing for the investigation of how multiple potentially sound-symbolic factors impact listener perception. Findings demonstrated that the “bouba-kiki” effect is produced by a combination of multiple phonetic features, and that sound/shape association extends to real-world objects in addition to abstract shapes.

2.4. FUNCTIONAL ROLES. Sound symbolism plays several functional roles within language. A study involving native English speakers’ perception of Japanese haiku demonstrated that a high ratio of plosives to nasals (i.e., a less overall sonorant speech signal) is perceived as active and excited, while a low plosive to nasal ratio is perceived as calm and quiet. This association demonstrates that sound symbolism may play a role in conveying semantic meaning, particularly emotions, in poetry (Miller 2014). Additional research supports the idea that a shifting of mood or setting in literature could be indicated by a change in the contrasts between phonetic features which unconsciously signal the shift to the reader (Miall 2001). In English, sound symbolism may play a role in the classification of nouns and verbs. Examination of a corpus of words with a high lexical frequency showed that nouns are more likely to have back than front vowels, and verbs are more likely to have front than back vowels. This association of vowel quality with syntactic class impacts the processing speed of nouns and verbs: listeners process words more quickly if they have the expected vowel quality according to syntactic class, vs. words with an unexpected vowel quality (Serenio 1994).

2.5. SOUND SYMBOLISM IN PROPER NAMES. Much of the current research focuses on the forms sound symbolism takes in proper names, whether this use is conscious or unconscious, and what kinds of things can be symbolized. Kawahara and colleagues (2018) found a positive correlation in Japanese between the number of voiced obstruents in a name and the corresponding Pokémon’s size, weight, and evolution level; and the number of moras correlated with size, weight, evolution level, and strength. In an expansion of Kawahara’s original study, Shih and colleagues (2018) found that for both English and Japanese name length was positively correlated with size, power, and evolutionary stage.

A similar dataset to Pokémon involving real-world subjects was studied by Shih and colleagues (2019) in their investigation of sound symbolism in baseball player names, where they found that nicknames for smaller players are more likely to contain high vowels, and longer nicknames with sonorant consonants are more likely to belong to heavier players. No correspondence was found between physical characteristics and given names (Shih & Rudin 2019). Although given names may not hold sound symbolic characteristics with regard to variables like height and weight, studies on English, Mandarin, and Cantonese personal names have revealed that personal names may include sex-specific phonology.

English has been demonstrated to contain patterns in the phonology of male and female names (Cassidy, Kelly & Sharoni 1999; Cutler, McQueen & Robinson 1990; Whissell 2001). Female names are, on average, longer, more likely to have an unstressed initial syllable, more likely to end in a vowel or sonorant consonant, and more likely to contain the vowel [i] than male names. Male names tend to be shorter, end in a stop or fricative, and generally take the unmarked case, meaning that female names can be derived from male names, but male names cannot usually be derived from female names.

Female names are more likely to contain phonemes that are associated with characteristics such as pleasantness, passivity and softness, while male names are more likely to contain phonemes associated with activity, unpleasantness, and cheerfulness. These findings suggest that English personal names can convey abstract emotional concepts through their phonology, and that the emotional content of female names is different from that of male names (Whissell 2001). Research using a connectionist network showed that this pattern is learned in English speakers and that it can be used to infer sex from unfamiliar names. This learning process is likely largely unconscious and facilitated by repeated exposure (Cassidy, Kelly & Sharoni 1999).

Using a dataset of Mandarin and Cantonese personal names, Starr (2018) observes distinct distributions for male vs. female names. Female names are more likely to contain vowels that are high or front than male names, and female names are more likely to begin with a palatal consonant, while male names are more likely to begin with a retroflex, and to contain a short-lag obstruent onset or a final velar nasal. Starr links the distinction between palatals and retroflexes, in particular, to the frequency code hypothesis via their acoustic characteristics. This is congruent since the association of maleness with lower frequencies and femaleness with higher frequencies may be explained by the fact that biological males generally have deeper voices than biological females (Hinton, Nichols & Ohala 1994).

2.6. RESEARCH QUESTIONS. Although much research has been conducted on the phonology of female and male names in comparison to each other, there is a gap when it comes to examining name change over time, especially with a focus on sound-symbolic characteristics. This study expands the results of previous studies by taking a diachronic perspective. In addition to comparing male and female names to each other, we also compare male and female names to themselves across time. The goal for this study is therefore twofold: to examine potential sound symbolic characteristics in this dataset of American names, and to examine how these characteristics change over time.

3. Phonological characteristics of gendered names in English

3.1. THE CURRENT STUDY. The approach of the current study is modeled after a study conducted by Cutler and colleagues in 1990, which found distinct phonological distributions between female and male names. Using a dataset of 1667 names common in Britain in the 1980s, Cutler et al. found that female names are longer, more likely to end in a vowel or sonorant consonant, less likely to have initial primary stress, and more likely to contain the vowel [i]. We test whether a subset of these results extend to names popular in the United States, and we expect the outcomes of the current study to align with Cutler et al.'s (1990) findings.

Our dataset consists of 1200 unique names across 14 decades. Patterns in this dataset are first described and visualized, then modeled statistically with a Generalized Additive Model to capture change across time. We expect to find distinct phonological distributions between female and male names, where female names are longer, less likely to end in a consonant, less likely to have initial primary stress. We hypothesize that there will be differences in the distributions of initial vowels for female and male names, although we do not evaluate specifically the presence of [i] within names. We also expect to find change over time, and hypothesize that names will become less distinctly gendered as the decade increases, due to the general societal trend away from the strict gender norms of the 20th century.

3.2. DATA COLLECTION. Data was sourced from the United States Social Security Administration (<https://www.ssa.gov/OACT/babynames/decades/>). The top 400 most popular names (200 male, 200 female) were obtained for each decade from 1880 to 2010; this decade span represents all of

the name data currently available on the Social Security Administration’s website. This resulted in 14 total decades being examined. The final dataset contains 5600 total names, with 1211 of those being unique. The data came pre-coded for decade, rank within decade, number of individuals with a particular name within the decade, and the sex of the name. The rest of the variable coding was done by hand by the first author, a native speaker of American English.

3.3. ANNOTATION. The data was coded for four variables: number of syllables, stress pattern, final phoneme (consonant or vowel), and initial vowel. These variables were selected based on the results of similar literature, where these four variables were the most significant predictors of name sex across multiple studies (Cassidy, Kelly & Sharoni 1999; Cutler, McQueen & Robinson 1990; Whissell 2001). Stress was evaluated based on the stress of the first syllable of the name, and names were placed in one of three stress categories. Primary stress, meaning that the initial syllable was stressed; secondary stress, meaning that the initial syllable had secondary stress; and unstressed, meaning that the initial syllable was unstressed. In names with multiple pronunciations resulting in more than one option for the stress pattern, the most common pronunciation was selected. If the most common pronunciation was not evident, the stress patterns available on <https://www.babynamewizard.com> were used as a reference.

4. Descriptive results

4.1. PHONOLOGICAL RESULTS. Initial visualizations of the data demonstrate results consistent with expectations given the results of previous research. Figure 1, a boxplot of the average number of syllables in a name, shows that female names are, on average, longer than male names. An independent two-tailed t-test was performed to compare the average number of syllables in male vs. female names, and we found the difference between the averages to be statistically significant ($t(24.856) = -6.5709, p = <0.001$).

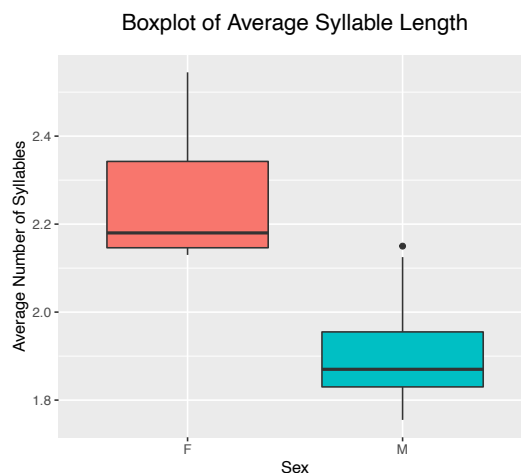


Figure 1. Boxplot of average syllable length

The graph in Figure 2 is a boxplot of the distribution of final phonemes, where names can either end in a consonant or a vowel. An independent two-tailed t-test was performed to compare the distribution of final phonemes for male and female names. The differences in distribution for both consonants and vowels was statistically significant: $t(15.666) = 17.135, p < 0.001$ for consonants and $t(15.723) = -17.265, p < 0.001$ for vowels.

The final graph comparing male and female names is a boxplot of initial syllable stress (Figure 3). This graph is supported by the results of an independent two-tailed t-test performed for

each facet. The t-test evaluated the difference between the distribution of stress patterns between male and female names for primary stress ($t(19.881) = 11.308, p < 0.001$), secondary stress ($t(22.812) = -5.4197, p < 0.001$) and unstressed initial syllables ($t(13.984) = -13.885, p < 0.001$).

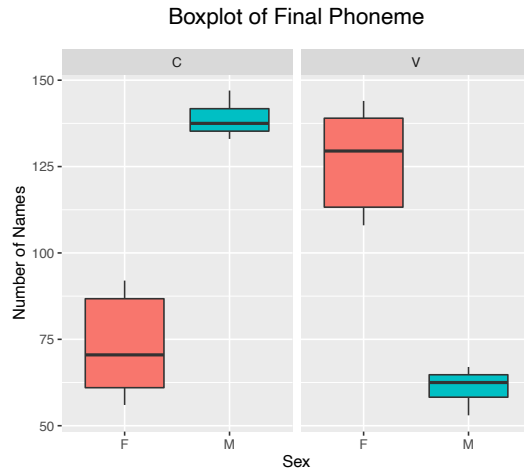


Figure 2. Boxplot of final phoneme distribution

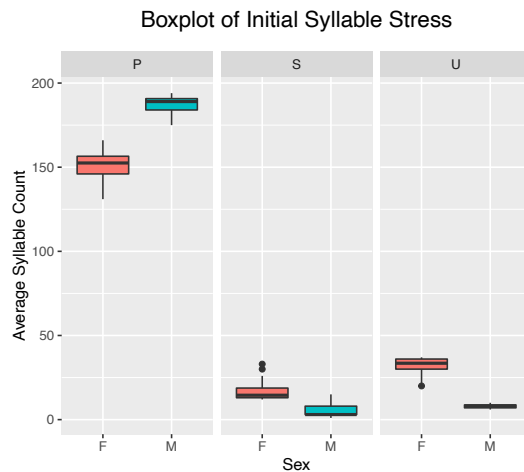


Figure 3. Boxplot of initial syllable stress distribution

4.2. CHANGE OVER TIME. The graphs in Figures 4 – 6 demonstrate non-linear change over time for each variable. In Figure 4, male names show a general trend downward until 1960, when they gradually begin to get longer until they trend downward again starting in 2000. Female names show a similar, but not identical, pattern, with a less pronounced downward trend until 1960, after which they begin to increase in length until they too begin to trend downward from 2000 to 2010. 1880 and 1970 were the decades with the most similarity, while 1950 and 1960 demonstrate the greatest difference between the sexes.

Figure 5 demonstrates that, in all decades, women's names are more likely to end in a vowel, and show much more fluctuation across time than men's names. The mid-20th century displays the greatest similarity between the sexes, with patterns diverging again with late Baby Boomers and early Gen-Xers in the 1960s. In the late 20th Century, women's names maintain high rates of final vowels (70%), while men's names also have increased rates of final vowels (34%). The trend for 2010 indicates a decrease in final vowels for men.

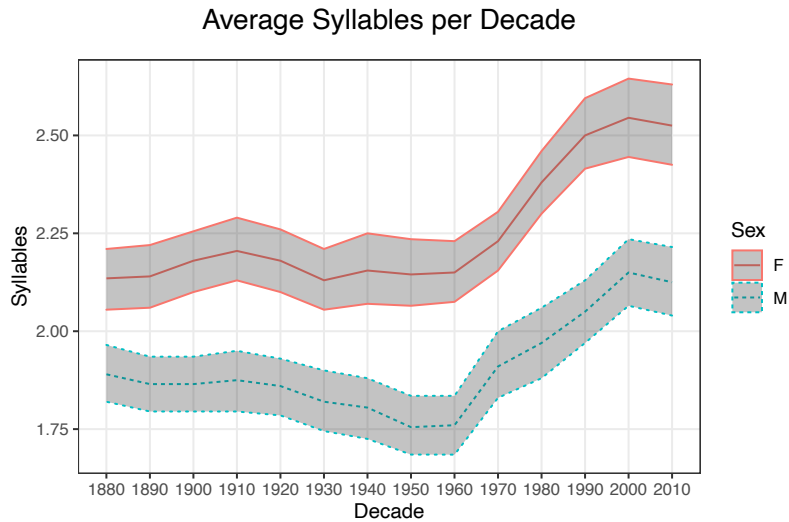


Figure 4. Graph of name length over time

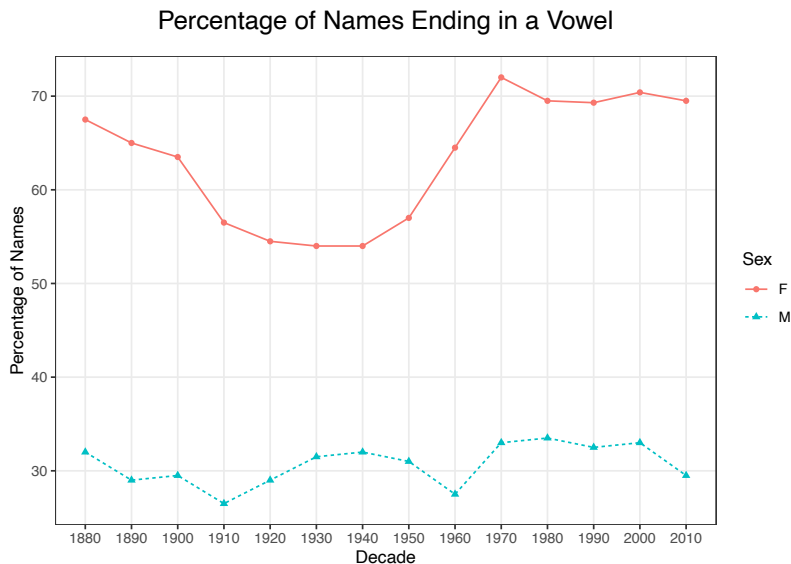


Figure 5. Graph of final phoneme distribution over time

As demonstrated in Figure 6, in all decades, women’s names are less likely to have initial stress (percentage per decade 65% – 83%), and men’s names are less likely to have initial stress (percentage per decade 65% – 83%). For both sexes the likelihood of a name with initial stress is relatively high. The greatest similarity between women and men occurred in the late 19th Century, when women’s names were most likely to have initial stress. Over time, women’s names have steadily trended away from initial stress, with a slight uptick around 1970 followed by a sharp drop (77% – 65%). Men’s names have varied less over time, with the greatest likelihood of initial stress in the 1950s, followed by a drop. The peak rate of non-initial stress for both women and men occurred in the 2000s, with a slight uptick in the 2010s.

Examination of Fig. 4 – 6 leaves us with three important conclusions. First, there is evidence of change over time: none of the three variables show consistency across the decades. Occasionally this change over time aligns, such as in the 1960s when all three variables exhibit

simultaneous trends towards female name characteristics. Second, this change over time is not identical for each sex. Male and female names show similar, but not identical patterns of change. Most notably, male and female names exhibit similar trends towards longer names beginning in 1960, and similar trends towards initial primary stress beginning in 2000. Third, these graphs show us that this change over time is not linear. This must be taken into consideration when planning a method of statistical modeling as, for example, a linear regression model fit to this dataset would not accurately represent the amount of variation in the data. Approaches to modeling this dataset are discussed in the following section.

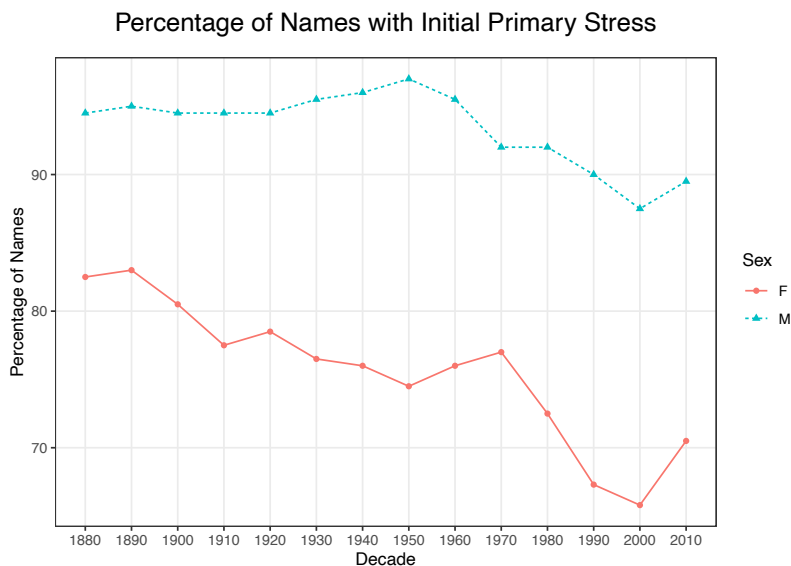


Figure 6. Graph displaying percentage of names with initial primary stress

5. Statistical Modeling

5.1. APPROACHES TO STATISTICAL MODELING. Preliminary modeling with linear regression failed to adequately capture the variation in the dataset, and that, along with the results from Fig. 4-6 above, informed the direction of the current approach. Modeling this dataset requires a method that allows for a nonlinear relationship between x and y . Note that the data in Figure 4-6 is not only a curve, but a curve with wiggles. Modeling curves with polynomials (e.g, Renwick & Olsen 2017) offers a diverse and fairly straightforward method of evaluation; however, the current dataset encounters its limits. Using a polynomial curve to model very wiggly data can result in Runge’s phenomenon (Epperson 1988), where the increasingly higher-order polynomials required to fit the wiggles causes oscillations at the edges of the graph. Thus, the approach decided on for this dataset was a generalized additive model (GAM; Hastie & Tibshirani 1986), the non-parametric equivalent of a generalized linear model, which has been shown to be useful when modeling wiggly data (Winter & Wieling 2016). Statistical modeling conducted using a GAM allows for the inclusion of non-linear smooth terms alongside parametric linear predictors. In short, this allows for the inclusion of the non-linear variable of time in the current model, fulfilling the original goal of examining change over time in this dataset.

5.2. MODELING WITH A GAM. A GAM was fit using the dependent variable of sex, and the independent variables of stress (reference level = Primary), final phoneme (reference = C), initial vowel (reference = [æ]), and number of syllables (treated categorically; reference = 1), plus

decade as a non-parametric smooth term, interacted with syllable count. Variable selection was then conducted using a stepwise method, where all available variables were found to be significant predictors. Finally, an interaction between decade and number of syllables was found to be significant. Table 1 displays the results of model comparisons. Selection criteria included AIC, R^2 value, and degrees of freedom. Model comparison was conducted by comparing the fit of the full model against a model that drops a single term. An increase in AIC in the dropped model indicates that the full model out-performs the dropped model. A p value of < 0.05 resulting from the model comparison indicates that this difference is significant. In all comparisons, $p < 0.05$. Based on these criteria, the best fit model includes both all available predictors and the interaction between syllables and decade.

Model Comparisons for GAMs	AIC	R^2	df
Full Model	6569	0.206	30
Decade dropped vs. full	6596	0.201	22
Interaction dropped vs. full	6588	0.203	24
Syllables dropped vs. full	6724	0.180	27
Stress dropped vs full	6749	0.173	28
Final phoneme dropped vs. full	7068	0.120	29
Initial vowel dropped vs. full	6673	0.186	15

Table 1. Table of model comparisons. In all cases, $p < 0.05$.

6. Quantitative results.

6.1. MODELING RESULTS. A model summary for the final GAM can be seen in Tables 2 and 3 below. Table 2 contains the model output for the parametric terms, and Table 3 contains the model output for the non-parametric smooth term, decade. For the purposes of space, and with the goal of making the table as straightforward as possible, model output for initial vowels not deemed significant predictors¹ was not included in the table. A positive estimate indicates an increased likelihood of a name being female. The effects of non-linear terms are difficult to interpret directly from the model output, so a common technique is to extract predicted values for visual interpretation. An examination of Fig. 7 and Fig. 8 offers a more easily interpretable way to assess the output of the final model.

Variable	Estimate	Standard Error	z value	Pr(> z)
Intercept	-1.066	0.1158	-9.205	< 0.001 ***
Syllables: 2	0.3777	0.1009	3.745	< 0.001 ***
Syllables: 3	1.470	0.1325	11.095	< 0.001***
Syllables: 4	0.6140	0.3334	1.842	0.0655
Stress: Secondary	0.2170	0.1842	1.178	0.2389
Stress: Unstressed	1.894	0.1507	12.567	< 0.001 ***
Final Phoneme: V	1.407	0.0650	21.640	< 0.001***
Initial Vowel: [aɪ]	-0.6054	0.1758	-3.443	< 0.001***
Initial Vowel: [ɑ]	-0.7175	0.1137	-6.309	< 0.001 ***

¹ [aʊ eɪ oʊ ɔ u]

Variable	Estimate	Standard Error	z value	Pr(> z)
Initial Vowel: [ə]	-0.9739	0.2501	3.894	< 0.001 ***
Initial Vowel: [ɛ]	-0.3470	0.1201	-2.889	0.0039 **
Initial Vowel: [i]	-0.3729	0.1453	2.566	0.0103 *
Initial Vowel: [ɪ]	-0.3797	0.1107	-3.429	0.0006 ***
Initial Vowel: [ɔɪ]	-0.9140	0.3966	2.305	0.0212 *
Initial Vowel: [ʊ]	3.111	1.072	2.903	0.0037 **
Initial Vowel: [ʌ]	-1.415	0.3843	3.681	0.0002 ***

Table 2. Table of final model output for parametric terms

Variable	Estimated DF	Reference DF	Chi ²	p-value
Decade x Syllables: 1	1.000	1.000	2.508	0.113
Decade x Syllables: 2	1.076	1.148	0.610	0.534
Decade x Syllables: 3	3.109	3.580	34.094	<0.001 ***
Decade x Syllables: 4	1.001	1.003	0.056	0.814

Table 3. Table of final model output for non-parametric term.

Fig. 7 and Fig. 8 show how the probability that a name with expected female characteristics (3 syllables, ending in a vowel) changes over time. When looking at these graphs it is important to note that they are on very different scales. This was chosen intentionally to provide the most robust depiction of the change over time that is occurring. What the difference in y-axis scaling might not make explicitly obvious is that the predictions for male and female names never overlap. Their predicted values are always different, supporting the original hypothesis that female and male names have distinct phonological distributions.

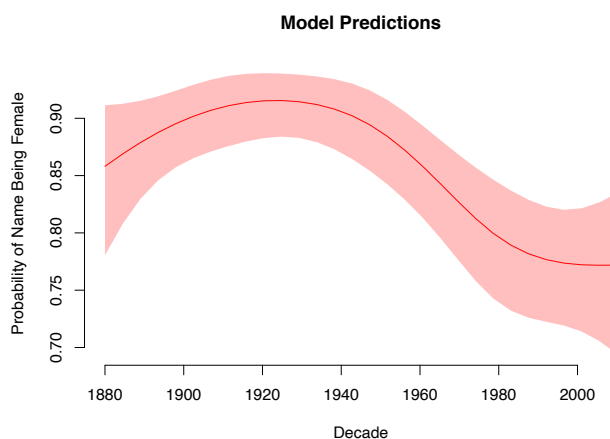


Figure 7. Model predictions for a female name with expected female characteristics.

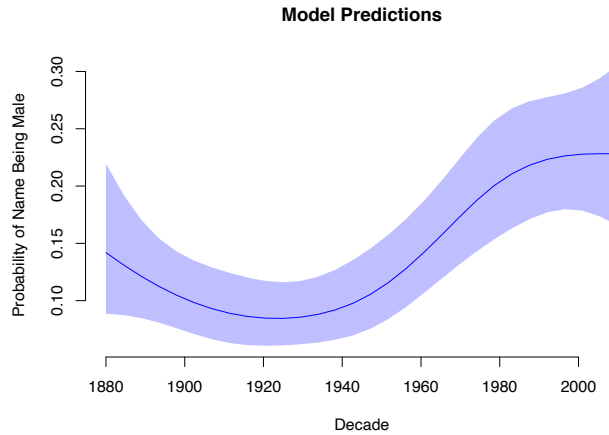


Figure 8. Model predictions for a male name with expected female characteristics.

Female names, are, as expected, consistently far more likely to have female name characteristics. However, it is important to note that there is fluctuation across time for the predictions of both male and female names. This is consistent with what we saw in Figs. 4 – 6 regarding change over time, and provides further support for our choice to use a GAM to model this dataset. The model predicts that female names have a higher probability of expected female name characteristics in 1920, and then become less likely to show expected values moving towards the year 2000. Interestingly, this graph shows that male names are becoming slowly more likely to have female name characteristics. Taken in combination, these graphs show us that male and female names have converged slightly since 1880, such that they are now less likely to have extreme values based on their expected sex.

7. Discussion and conclusion.

7.1. SUMMARY OF FINDINGS. Findings from the current study align with what was expected given previous research. Results regarding the phonological distribution of male and female names align with the findings of Cutler et al. (1990), where female names are longer, more likely to end in a vowel, and less likely to have initial primary stress. Additionally, we have found evidence of name change over time for both male and female names, indicating that baby naming trends in the United States experience variation throughout the decades. We have demonstrated that the results obtained by Cutler and colleagues (1990) are not limited to their dataset of names popular in England in the 1980s, and can be extended to a dataset of names popular in the United States over a range of decades.

7.2. RELEVANCE TO THE STUDY OF SOUND SYMBOLISM. The study of names is an interesting subset of the study of sound symbolism, as it relies on generalized conclusions or stereotypes reached by an entire community. Some researchers have posited potential explanations for this, looking to sociology, anthropology, and previous research on character names for insight (Cassidy, Kelly & Sharoni 1999; Cutler, McQueen & Robinson 1990; Whissell 2001; Shih et al. 2019; Uno et al. 2020). While definite conclusions cannot be drawn for the underlying causes of the phonological distinction between male and female names, the results of this study can be used along with other relevant literature to further our understanding of the subset of language where sound and meaning interact in an intentional manner. As this study involves a large subsection of names across many decades, it provides evidence for sound symbolism as a longstanding component of language that has made its way into daily life.

7.3. CONCLUSION AND FUTURE DIRECTION. Future research would benefit from two avenues of exploration: an explanation for change in naming trends over time, and an integration of non-arbitrary data into formal phonological theory. There are three possibilities that we have currently identified as potential explanations for variation over time, and all would benefit from future investigation. The first involves potential internalized preferences rooted in sound-symbolic principles, so as societal perceptions of maleness and femaleness evolve, so might the reflection of that perception in baby names. Shifts in naming practice may be driven by social factors below the level of individual parents' awareness; as described by Lieberman (2000), a structural factor termed the "ratchet principle" helps promote new social behaviors above the old, resulting in fashion-based changes (cf. Labov 2002).

Second, demographic shifts in the United States result in a diversification of the linguistic origins of names in the United States, which could contribute to change over time. These trends are richly investigated within demography and economics. For instance, US naming diversity increased from the 1850s to the 1920s: a decreasing proportion of children were assigned one of the top 50 most popular names (Olivetti & Paserman 2015). That period also saw peaks of immigration to the United States, during which trends in baby naming convey information about individuals' socioeconomic status (Olivetti & Paserman 2015, Table 1). It would be interesting to compare immigration records with specific moments of linguistic change in our dataset.

Third, naming patterns are linked to aspects of social identity, like a person's ethnic heritage, and the strength of these associations may change over time. In long-standing US Hispanic communities like Denver and Albuquerque, Hispanic first names have given way to Anglo first names or the English equivalent of traditional Hispanic names, while in cities like Miami and Tampa with more foreign-born Hispanics, Spanish names and spellings predominate (Lavender 1988, Table 3). Relatedly, an examination of trends in first names, among Latinos attending a Chicago university, showed that the prevalence of Anglo names increased with greater generational time depth from immigration (Parada 2016, Table 3). Among African Americans there are long-standing traditions of popular Black names, though late-20th Century trends diverge from 19th Century monikers (Cook, Logan & Parman 2014). Racialized naming practices are entwined with socioeconomic and cultural factors relevant to African Americans, including mortality: analysis of death certificates shows that "those with distinctively African American names lived nearly a year longer than other African Americans" (Cook, Logan & Parman 2016: 122), a positive outcome for onomastic diversity.

Finally, a helpful question to ask moving forward is how does non-arbitrary data like this integrate into formal phonological theory? Is it possible, and if so, what does that look like? This is a question that has been asked previously by Stephanie Shih (2020), who examined gradient category membership in lexically conditioned phonology. Her primary point is that all non-arbitrary data, sound symbolic or otherwise, has been overlooked in the realm of formal phonological theory. The patterns in sound symbolic data are, in their essence, not so different from binary or arbitrary data that it prevents their formal phonological examination. Much time has been spent arguing for the validity of sound symbolic characteristics, and it would benefit future research to look past simply arguing for their existence and moving towards a more formal approach to their integration into the larger realm of phonological theory.

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