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The Voiced Pronunciation of Initial Phonemes Predicts the Gender of Names

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Although it is known that certain names gain popularity within a culture because of historical events, it is unknown how names become associated with different social categories in the first place. We propose that vocal cord vibration during the pronunciation of an initial phoneme plays a critical role in explaining which names are assigned to males versus females. This produces a voiced gendered name effect, whereby voiced phonemes (vibration of the vocal cords) are more associated with male names, and unvoiced phonemes (no vibration of the vocal cords) are more associated with female names. Eleven studies test this association between voiced names and gender (a) using 270 million names (more than 80,000 unique names) given to children over 75 years, (b) names across 2 cultures (the U.S. and India), and (c) hundreds of novel names. The voiced gendered name effect was mediated through how hard or soft names sounded, and moderated by gender stereotype endorsement. Although extensive work has demonstrated morphological and physical cues to gender (e.g., facial, bodily, vocal), this work provides a systematic account of name-based cues to gender. Overall, the current research extends work on sound symbolism to names; the way in which a name sounds can be symbolically related to stereotypes associated with its social category.

Keywords: names, gender, sound symbolism

Imagine you run into your colleague at a conference and discover that your colleague recently had a newborn baby. What would you ask this new parent about this newborn? We asked 100 people this question and the two most common responses were “Is it a boy or a girl?” and “What is its name?” (see the Appendix). The current work reveals that there is a deep, symbolic relationship between the answers to these two questions. This relationship even exists at the phonetic level. The current research identifies a voiced gendered name effect, whereby voiced phonemes are associated with male names and unvoiced phonemes are associated with female names. Relative to the large body of work examining morphological and physical cues to gender (e.g., facial, bodily, vocal; Adams, Ambady, Nakayama, & Shimojo, 2011), little work has examined the theoretical basis of how names are assigned to a particular gender, or to a particular social category more broadly. Unlike many of the cues to gender (facial features, body shape, hair style), which develop over time, a name is *given immediately* to a person, often before he or she is even born.

Each person has a given name, and this name can have drastic consequences (Fryer & Levitt, 2004; Laham, Koval, & Alter, 2012). Consider the racial and gender associations of names. The exact same résumé receives more interviews when an applicant has a “White-sounding” name (e.g., Emily, Greg) compared with a “Black-sounding” name (e.g., Lakisha, Jamal; see Bertrand & Mullainathan, 2004). Similarly, academics perceive research applicants as more competent and hireable for a laboratory manager job if the applicant is named John versus Jennifer (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012).

The current research contributes to a century-long debate: Does the sound of certain classes of words symbolically relate to their referents? We explore the systematic effect of phonetic qualities of given names by investigating the link between *sound symbolism* and gender. The idea of sound symbolism is that for certain words, the sound that represents that word is not arbitrary, but rather symbolically represents the word’s referent (i.e., the association between what a word sounds like and what it represents is symbolic; the word’s sound symbolically conveys qualities of the object that the word represents).

Building off the sound symbolism account, we examine whether there is a voiced gendered name effect: whether voiced phonemes (those pronounced with the vibration of vocal cords) are more associated with male names and unvoiced phonemes (those pronounced without the vibration of vocal cords) are more associated with female names. We conducted 11 studies that test this association (a) using 270 million names (and more than 80,000 unique names) given to children over 75 years, (b) names across two cultures (the U.S. and India), (c) examining hypothetical and actual baby naming, including with expecting parents, and (d) using hundreds of novel names in experiments. We integrate this research with work on gender stereotypes through both mediation (whether the sound is

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judged to be hard or soft) and moderation (by gender stereotype endorsement).

Name Phonology

There has been interest in the phonology of names, in particular how female names differ from male names,[1] but this literature is largely descriptive. That is, prior researchers have gathered the most popular male and female names, and simply compared their phonology, and wherever names differed statistically, those differences were noted. For example, male names tend to have fewer consonants, whereas female names have more consonants. Additionally, female names are far more likely to end in a schwa vowel [ə], for example, "Maria," "Amanda." It is unclear, however, why this pattern emerges. For example, it might be an instance of female names retaining the feminine ending of Latin etymology, but this is unknown (Cassidy, Kelly, & Sharoni, 1999). Thus, it is not clear *why* there are these differences between female and male names, but it is clear that these differences exist, with individuals having implicit awareness of some of these differences. For example, when asked to complete the sentence, "After Corla went to bed . . ." participants were far more likely to next write, "she" to complete the sentence (the novel name ending in a schwa vowel), relative to "Colark," (the novel name not ending in a schwa vowel) in which case participants were more likely to write "he" (Cassidy et al., 1999).

Although this work (see also Barry & Harper, 1995; Cutler, McQueen, & Robinson, 1990) opens up a window into the *phonology* of names, it does not fully shed light on the *psychology* of names. That is, prior work has documented some phonetic differences in male and female names, but has not tested a theory of the origin of those phonetic differences. Although certain names may become conventional for males, and others conventional for females, little is known about why some names become assigned to males, and other names assigned to females. We present evidence that whether a name is more likely given to a male or female is not arbitrary, but depends on the way those names symbolically resemble (through how they sound) the social traits attributed to gender categories.

Sound Symbolism

Ever since early theories of language, the predominant view of the relationship between what a word sounds like and its meaning is that it is an arbitrary one (de Saussure, 1916). This arbitrary relationship between sound and meaning has been proposed to be a fundamental feature of language, expanding its referential ability (Gasser, 2004; Monaghan, Christiansen, & Fitneva, 2011). Yet, the idea of a complete arbitrariness between a word's sound and its meaning has long been challenged, suggesting that in some cases sounds may symbolically represent their referents. Indeed, beginning with Köhler (1929), a number of studies have provided evidence suggestive of the existence of *sound symbolism*. Sound symbolism is an instance of the sound of a word being symbolically associated with the word's referent. This is not to be confused with onomatopoeia, whereby a word simply attempts to *physically* imitate a sound (e.g., "bang," "whoosh").

The idea of sound symbolism is also distinct from the relationship recently found between articulation dynamics and attitudes. For instance, consonants can be pronounced at various places, including the front of the sagittal plane (i.e., pressing the lips, such as when pronouncing [p] or [b]) versus the rear (i.e., the rear of the tongue; such as when pronouncing [g] or [k]). Consequently, the sequence of consonantal articulation could occur in a particular order, including moving from the back to the front of the mouth (i.e., outward; e.g., "gap," "cab"), or from the front to the back of the mouth (i.e., inward; e.g., "pick," "big"). These physical inward and outward movements from consonantal articulation dynamics promote attitudes based in similar *physical* movements (i.e., bringing inward is akin to approach, and pushing outward is akin to avoidance); *inward* consonant sequences promote *approach* motivation, and *outward* consonant sequences promote *avoidance* motivation (Topolinski, Maschmann, Pecher, & Winkielman, 2014). Similarly, articulation dynamics that produce face muscle contractions that physically resemble smiling lead to heightened mood, as demonstrated by judging cartoons as funnier (Rummer, Schweppe, Schlegelmilch, & Grice, 2014).

In contrast to a direct physical correspondence, the sound symbolism hypothesis is that the way in which a word sounds has *symbolic* or metaphorical resemblance to the qualities of the object that the word names. For instance, Köhler's classic example is that given two shapes (curvy and spiky) and two names, "baluma" and "takete," people prefer to name a curvy round object as "baluma" and a spiky angular shape as "takete." Modern replications demonstrate the robustness of this effect (e.g., with 95% of participants matching "kiki" to a spiky object and "bauba" to a round object; Ramachandran & Hubbard, 2001). These correspondences are interpreted as suggesting, for example, that the "sharp" and quick sounds of "kiki" symbolically match the angular shape of a spiky object, and likewise that the "rounded" and relaxed sounds of "bauba" symbolically match the smooth shape of a round object. Effects such as these have been demonstrated not only with adults, but also with prelinguistic 4-month-olds (Ozturk, Krehm, & Vouloumanos, 2013), 2.5-year-old children (Maurer, Pathman, & Mondloch, 2006), and older children across cultures (Davis, 1961). Moreover, these effects have been found in more methodologically advanced designs and measures (rather than simple forced choice tasks), including learning paradigms (Imai, Kita, Nagumo, & Okada, 2008), lexical decisions (Westbury, 2005), object recognition (Aveyard, 2012), and electroencephalographic waveforms (Kovic, Plunkett, & Westermann, 2010).

Despite this body of literature, many language theorists consider such examples as rather rare, and thus view the phenomenon of sound symbolism as marginal to the undeniable arbitrariness between word meanings and sounds (Newmeyer, 1992). More problematically, Westbury (2005) reviewed experimental evidence for sound symbolism and concluded that it is rather weak. This con-

[1] In the current paper, when describing gendered names, we often use the terms "male" and "female" in place of "boys"/"men" and "girls"/"women." The APA defines the former as biological sex and the latter as cultural labels for gender. We do not mean to suggest, however, that naming patterns across gender have anything to do with biology. Rather, our account is a culturally-based one, which is why we describe it as the voiced gendered name effect. The terms "male" and "female" are used because these words efficiently encapsulate broad age rages, which thereby avoids wordy descriptions of age (e.g., rather than describing names conventional for both "boys and men" ("girls and women"), we simply say "males" ("females").

clusion is driven in part by the fact that much of the experimental work relies on small sets of stimuli, and manipulations that are readily apparent to experimental participants.

The Voiced-Gendered Name Hypothesis

In the present work, we examine the names people give to other people. Rather than study arbitrarily chosen words, or exclusively nonsense words, we test whether there is consistent evidence for sound symbolism with a new theory-based approach. Our approach to sound symbolism has several novel features. First, we examine the names that people give people, rather than objects. The switch from objects to people comes with a host of advantages. For example, we can examine detailed records of every name given to babies in the U.S. over the past 75 years for a careful look at the phonology of names.

Additionally, names give cues to social categories, which in turn activate stereotypes. By considering how the names people give to other people might symbolically represent those stereotypes, we link the literature on sound symbolism to the literature on social cognition. The most basic social category divide is gender, and female's names do differ phonetically on some dimensions from male's names. For example, names ending in a schwa vowel [ə] (the common final phoneme in "Maria," "Amanda," and "Noah") are more often assigned to females (Cassidy et al., 1999). Thus male and female names may sound different, but there is only post hoc speculation about why such phonetic differences have become the convention. One way that names differ is whether their initial phonemes are voiced or unvoiced. That is, just as there is a basic category distinction between people (male, female), there is basic category distinction between phonemes (voiced vs. unvoiced). Voiced and unvoiced phonemes differ in whether the vocal cords vibrate during the expelling of air. To experience this difference, we suggest the reader pronounce the words "this" and "thin" aloud while placing a finger on the laryngeal prominence (i.e., the "Adam's apple"). The *th* sound [ð] in *this* is voiced, whereas the *th* sound [θ] in *thin* is unvoiced. Or, pronounce the words "bear" and "pear." One should notice in both examples (during the *first* phoneme) a vibration present in the former words ("this," "bear"), but not the latter words ("thin," "pear"), with the initial phonemes in the latter words sounding more breathy. This difference affects how each phoneme sounds to the ear (see Table 1 for which phonemes are voiced/unvoiced).

We propose that the vibration of the vocal cords leads voiced phonemes to produce a harder or harsher sound through modulating the flow of air. In contrast, unvoiced phonemes produce a softer, breathier sound given that they are produced by an opening of the air path not modulated by vibrating vocal cords. We further propose that these auditory qualities of voiced and unvoiced phonemes (e.g., as sounding "hard" or "soft") predict the gender of names. That is, we suggest that a link from voiced phonemes to gendered names occurs because names pronounced with an initial voiced phoneme sound "harder," and names pronounced with an initial unvoiced phoneme sound "softer," and because women are stereotypically described as being more "soft" and tender than

Table 1
Presentation of Different Sample Phonemes (Examples 1–4) That Can Be Pronounced From Different Letters as Well as Which Phonemes Are Studied in Each Study

Letter	Voiced	Example 1	Example 2	Voiced	Example 3	Example 4	Studies
A	✓	Adam [æ]	Amanda [ə]		—	—	1–3, 8, 10–11
B	✓	Brian [b]	—		—	—	1–11
C	×	Carol [k]	Chelsea [tʃ]				1–11
D	✓	David [d]	—		—	—	1–11
E	✓	Edward [ɛ]	—		—	—	1–3, 8, 10–11
F	×	Fiona [f]	—				1–11
G	✓	Gregory [g]	Gerald [dʒ]		—	—	1–11
H	×	Heather [h]	—				1–3, 8, 10–11
I	✓	Isabella [i]	Ian [iː]		—	—	1–3, 8, 10–11
J	✓	Jessica [dʒ]	—	×	José [h]	—	1–11
K	×	Katharine [k]	—				1–11
L	✓	Lauren [l]	—		—	—	1–3, 8, 10–11
M	✓	Michael [m]	—		—	—	1–3, 8, 10–11
N	✓	Nicholas [n]	—		—	—	1–3, 8, 10–11
O	✓	Owen [o]	Oliver [a]		—	—	1–3, 8, 10–11
P	×	Peggy [p]	Phillip [f]				1–11
Q	×	Quentin [k]	—				1–3, 8, 10–11
R	✓	Rachel [r]	—		—	—	1–3, 8, 10–11
S	×	Sarah [s]	Sean [ʃ]				1–11
T	×	Timothy [t]	Theodore [θ]				1–11
U	✓	Ursula [ɜː]	—		—	—	2–3, 8, 10–11
V	✓	Vincent [v]	—		—	—	1–11
W	✓	William [w]	—		—	—	1–3, 8, 10–11
×	✓	Xenia [z]	—	×	Ximena [h]	Xochitl [s]	2, 3
Y	✓	Yoshi [j]	Yvette [iː]		—	—	1–3, 8, 10–11
Z	✓	Zachary [z]	—		—	—	1–11

Note. Columns "Example 3" and "Example 4" are reserved for the few cases in which the same letter can be pronounced both with a voiced, and an unvoiced, phoneme.

men, and men are stereotypically described as more "hard" and tough than women (Slepian, Weisbuch, Rule, & Ambady, 2011; see also Broverman, Vogel, Broverman, Clarkson, & Rosenkrantz, 1972; Prentice & Carranza, 2002; Zhang, Li, Eskine, & Zuo, 2014). William James (1907), for example, used "tough-minded" and "tender-minded" interchangeably with "masculine" and "feminine," respectively.

Given these links between hard/soft and male/female on the one hand and voiced/unvoiced phonemes on the other, we predict that names that begin with a voiced phoneme will be more likely given to males, whereas names that begin with an unvoiced phoneme will be more likely given to females. We propose that through this process of associative-matching, the sound of a name determines whether it is more likely given to a male or female. In the current work, we test whether people give names to children in a manner that is aurally (i.e., through sound) metaphorically congruent with gender stereotypes (i.e., shared beliefs about the traits of women and men).

Overview

We conducted 11 studies to examine whether there is a voiced gendered name effect. In Studies 1 and 2, we examined individuals' names to establish the voiced gendered name effect. Study 1 asked 1,000 participants for their first names and examined whether male and female names are differentially voiced versus unvoiced. Study 2 then examined all names given to babies on record in the United States, from 1937 through 2013 (the final year available at the time the study was conducted), and included more than 270 million names to provide clear evidence that men's names are more often voiced, and women's names are more often unvoiced. Study 3 explored whether men's and women's names are judged as more masculine when beginning with a voiced phoneme, and more feminine when beginning with an unvoiced phoneme.

Studies 4 through 7 demonstrated the voiced gendered name effect experimentally, and also provided mediational evidence consistent with our sound symbolism account. Study 4 examined whether participants were more likely to categorize novel names as male when beginning with a voiced phoneme, and as a female when beginning with an unvoiced phoneme. Study 5 tested whether this effect was mediated by how hard or soft the novel names sounded. Studies 6 and 7 extended the previous studies by using a new set of novel names and by using synthesized audio clips that pronounced the names.

Studies 8 and 9 demonstrated that the voiced gendered name effect extended to another culture (India), and Study 10 found that these effects occur in a population of parents choosing names for their children. Finally, Study 11 tested whether the voiced gendered name effect would be moderated by gender stereotype endorsement; we expected that only to the extent that participants believed men were "hard" and women "soft" in their personalities would they judge hard-sounding names as masculine and soft-sounding names as feminine.

We only coded the first phoneme in each name; we considered a name that began with a voiced phoneme as a *voiced name*, and a name that began with an unvoiced phoneme as an *unvoiced name*. The first phoneme in one's name is given special prominence. For example, some documents only need to be initialed with the first letter of one's first and last name. Moreover, people tend to rate the first letter of their names more positively than other letters, found to reflect some aspects of self-esteem (Hoorens, Takano, Franck, Roberts, & Raes, 2015). It is also well established that the first processed feature of a target shapes the overall impression of that target (Asch, 1946). Because the first letter in a person's name is often given prominence and because the first processed feature of a target shapes the overall impression of that target, we hypothesized that the first phoneme would demonstrate the voiced gendered name effect, and thus test this hypothesis in the current work.

The current research implements notable methodological innovations to sound symbolism research. The current research attempts to mitigate methodological and conceptual problems in prior sound symbolism work (e.g., small sets of arbitrary novel stimuli) with three strategies. First, we examine sound symbolism in real names, analyzing more than 80,000 unique names, and when examined across time, more than 270 million individuals' given names. Second, we examine large sets of novel stimuli. Third, we draw on social–cognitive theories and examine the psychological mechanisms behind these judgments; although tests of mediation and moderation are common to social psychological research, they are absent in existing work on sound symbolism research.

Whereas the first strategy (i.e., examining real names, and millions of them) allows for firm conclusions about the existence of sound symbolism in in the real world, and the second strategy (i.e., experiments with novel stimuli) allows for causal claims, the third strategy (integrating social–cognitive theory) perhaps offers the biggest contribution. We extend the sound symbolism hypothesis to gender stereotypes (i.e., suggesting that people give stereotypically sound-symbolic consistent names to males vs. females). By doing so, a host of new theoretical intersections between sound symbolism and social cognition can be explored given that stereotypes can be endorsed to different amounts, can be activated and applied automatically, compete dynamically with other mental activations, and change across contexts, cultures, and time (see Brewer, 1988; Freeman & Ambady, 2009; Greenwald & Banaji, 1995; Smith & Semin, 2007; Wood & Eagly, 2012). Thus, we explore new intersections between language, metaphor, and social cognition, with implications for social categorization, judgments, and outcomes.

Study 1: The Voiced-Gendered Name Effect

Method

Participants and design. After participating in one of a number of unrelated online studies, 1,000 participants (M_{age} = 32.05 years, SD = 11.20; 56% men) were asked to provide their first name (if they were willing) for a separate study ostensibly on the "psychology of names" (933 complied).

Phoneme coding. We focused on the initial phoneme, and coded the initial (i.e., first) phoneme as either voiced or unvoiced, and applied this initial phoneme coding to the name, respectively, yielding what we term, voiced and unvoiced names (see Table 1). A trained research assistant coded each phoneme. This coding was achieved in three phases. First, initial letters that are invariably voiced versus unvoiced were coded as such (e.g., B is always voiced, and P is always unvoiced, no matter which phonemes follow). Second, for names that were highly common, initial letters that can be voiced or unvoiced, depending on the phonemes that follow, or the language from which the name originates, were pronounced and compared to objective phoneme charts (e.g., this process reveals that Jessica begins with a voiced phoneme, but José begins with an unvoiced phoneme). Finally, for each name with which the coder was not highly familiar, multiple online sources were consulted regarding how the name was pronounced; if any disagreement occurred for the prototypical pronunciation, whichever was the most often used pronunciation was chosen (e.g., Xenia is voiced, but Ximena and Xochitl are both unvoiced).

Each of the 470 unique names from these participants (counting distinct spellings of similar names as separate names to be consistent with Study 2) was coded as beginning with a voiced or unvoiced phoneme (see Table 1 for phoneme coding).

Results and Discussion

Voiced names more often belonged to males, and unvoiced names more often belonged to females, $\chi^2(1, N = 933) = 16.45$, $p = .03 \times 10^{-4}$, Cramér's $\varphi = .13$ (Table 2). Results held when examining only the 467 unique names given to only one gender (3 names were common to both genders), $\chi^2(1, N = 467) = 6.71$, $p = .01$, $\varphi = .12$ (Table 2).

One potential concern is that because all vowels are voiced, whereas consonants can be voiced or unvoiced, these results may be confounded by a vowel/consonant distinction. This alternative is rendered somewhat unlikely given that only 14% of our participants had names that began with vowels. To further ensure the results were not confounded by a vowel/consonant distinction, we reanalyzed the data, sampling only names beginning with consonants. Again, voiced names more often belonged to males, and unvoiced names more often belonged to females, $\chi^2(1, N = 800) = 25.76$, $p = .04 \times 10^{-5}$, $\varphi = .18$ (Table 2), and results held when examining only the 407 unique names given to only one gender (that began with consonants), $\chi^2(1, N = 407) = 7.43$, $p = .006$, $\varphi = .14$ (Table 2).

Study 2: U.S. Birth Data Over 75 Years and More Than 270,000,000 Names

Study 1 demonstrated that men's names were more likely to be voiced, whereas women's names were more likely to be unvoiced. To examine the reliability of these results, Study 2 utilized a much larger sample of names; all names on record given to children in the U.S. from 1937 to 2013 (270.88 million).

Method

Data were downloaded from the U.S. Government's Social Security database of Social Security card applications for births that occurred in the United States after 1936, and through 2013 (the latest year available when the work was conducted). These names are restricted to cases wherein the sex, year of birth, and state of birth are recorded, the given name is at least 2 letters long, and only names given to babies with at least five occurrences in a given year (for privacy reasons according to the U.S. Social Security Administration). Different spellings of similar names are not combined. Additionally, names from 1880 to 1936 are available from this database, but do *not* include all births meeting the above qualifications. That is, many people born before 1937 did not apply for a social security card when it was then introduced. Thus, we a priori decided to use names from 1937 and on given that names prior to 1937 do a particularly poor job of creating a representative sample of given names in the United States (including these names, however, does *not* change the pattern of frequencies or significance).

Results

Each name of the 87,620 unique names downloaded from this database was coded as voiced (beginning with a voiced phoneme) or unvoiced (beginning with an unvoiced phoneme). Again, first examining names only given to one gender, voiced names were more often assigned to boys, and unvoiced names were more often assigned to girls, $\chi^2(1, N = 270{,}881{,}430) = 1{,}980{,}992.48$, $p < .001 \times 10^{-300}$, $\varphi = .09$ (Table 3). Effects held when examining

Table 2
Study 1 Analysis of Online Participants' Names

Variable	Voiced	Unvoiced	Total
All names			
Male	399 (60.27%)	124 (45.76%)	523
Female	263 (39.73%)	147 (54.24%)	410
Total	662	271	933
Unique names only had by one gender			
Male	159 (51.62%)	62 (38.99%)	221
Female	149 (48.38%)	97 (61.01%)	246
Total	308	159	467
All names beginning with consonants			
Male	341 (64.46%)	124 (45.76%)	465
Female	188 (35.54%)	147 (54.24%)	335
Total	529	271	800
Unique names beginning with consonants only had by one gender			
Male	131 (52.82%)	62 (38.99%)	193
Female	117 (47.18%)	97 (61.01%)	214
Total	248	159	407

Table 3
Study 2 Analysis of United States Baby Names From 1937–2013

Variable	Voiced	Unvoiced	Total
All names			
Male	101,389,967 (54.40%)	38,177,828 (45.18%)	139,567,795
Female	84,983,578 (45.60%)	46,330,057 (54.82%)	131,313,635
Total	186,373,545	84,507,885	270,881,430
Unique names given to only one gender			
Male	18,321 (35.64%)	8,698 (32.36%)	27,019
Female	33,089 (64.36%)	18,178 (67.64%)	51,267
Total	51,410	26,876	78,286
All names beginning with consonants			
Male	85,147,650 (56.98%)	38,177,828 (45.18%)	123,325,478
Female	64,274,621 (43.02%)	46,330,057 (54.82%)	110,604,678
Total	149,422,271	84,507,885	233,930,156
Unique names beginning with consonants given to only one gender			
Male	14,013 (36.70%)	8,698 (32.36%)	22,711
Female	24,170 (63.30%)	18,178 (67.64%)	42,348
Total	38,183	26,876	65,059

only the unique 78,286 names given to only one gender, $\chi^2(1, N = 78{,}286) = 83.68$, $p = .006 \times 10^{-17}$, $\varphi = .03$ (Table 3).[2]

We also examined the 9,334 unique names given to at least one boy and one girl. The name being voiced (vs. unvoiced) predicted the proportion that the name was given to boys (vs. girls), $b = .02$, $SE = .008$, $t(9332) = 2.62$, $p = .009$. Even when the same name is given to children of both genders, how likely it is to be assigned to one gender or the other can be predicted from whether the first phoneme of the name is voiced or unvoiced.

Again, we examined whether results held when only analyzing names beginning with consonants (84.20% of all names). When examining all names beginning with consonants, voiced names were more often assigned to boys, and unvoiced names were more often assigned to girls, $\chi^2(1, N = 233{,}930{,}156) = 3{,}019{,}396.42$, $p < .001 \times 10^{-300}$, $\varphi = .11$ (Table 3); these effects held when examining only the unique 65,059 names given to only one gender (beginning with consonants), $\chi^2(1, N = 65{,}059) = 130.52$, $p = .03 \times 10^{-28}$, $\varphi = .05$ (Table 3). Examining the 7,928 names beginning with consonants given to at least one boy and one girl also revealed the same pattern; the name being voiced (vs. unvoiced) predicted the proportion that the name was given to boys (vs. girls), $b = .03$, $SE = .009$, $t(7926) = 3.91$, $p = .001$.

Discussion

Studies 1 and 2 demonstrated that females are more likely to be given names that begin with an unvoiced phoneme, whereas males are more likely to be given names that begin with a voiced phoneme. This was demonstrated both by surveying a sample of 1,000 adults, and by examining all given names from U.S. birth records from 1937 through 2013 (and was not a function of a vowel/consonant distinction). Additionally, we demonstrated this pattern of results whether treating each name as a *token* (thus capturing the frequency per each name; i.e., treating each baby born as one data point), or as a *type* (thus capturing the voiced gendered name effect independent of name popularity; i.e., treating each name, independent of how many people were given it, as one data point). Moreover, for names that are given to both males and females, the first phoneme can predict which gender that name is given to more, with voiced names more often given to males, and unvoiced names more often given to females.

Study 3: Judgments of Masculinity and Femininity

Our sound symbolism account is that voiced versus unvoiced names are given to males versus females because they are stereotypically associated with masculinity versus femininity. In Study 3 we examined whether the first phoneme of names would influence how masculine or feminine those names were judged.

Method

Participants and design. Participants ($N = 80$; $M_{age} = 36.01$ years, $SD = 13.57$, 64% women)[3] were randomly assigned to judge 500 popular female names (250 voiced, 250 unvoiced; matched for frequency), or 500 popular male names (250 voiced, 250 unvoiced; matched for frequency).[4] When judging the 500

[2] Of course, like with any coding, there could be errors. Hand coding for phonemes was only necessary for about 10% of the data. Consequently, even if the coder made errors 10% of the time (which is a very high estimate; the coder was extensively trained), this would only yield a 1% error rate. With inferential statistics like $\chi^2 = 1{,}980{,}992.48$, $p < .001 \times 10^{-300}$, coding errors would have an extremely trivial influence on the significance of our results.

[3] All study designs collected at least 40 participants per study cell. Studies 3 through 5 ($n = 40$ per study cell) were conducted first. Studies 9 through 11 were conducted next and recruited $n = 100$ per study cell to ensure robustness. Studies 6 and 7 required 144 participants per study cell for an even counterbalanced design. Last, Studies 1 and 8 each recruited 1,000 participants in collecting names, and Study 2's data set consisted of approximately 270.88 million names. There were no repeat participants in the current work.

[4] In the current work, we had no a priori reason to predict any experimental effects in the current paper to be moderated by participant gender. Given that some effects include categorizing names by gender, or judging names by masculinity/femininity, one might wonder whether these effects interact with participant gender. In no study did we find a main effect of, or interaction with, participant gender, and thus participant gender is not discussed as a factor in the current work.

male names, the rating scale was from *feminine* (1) to *masculine* (7). When judging the 500 female names, the rating scale was from *masculine* (1) to *feminine* (7).

Stimuli. The 1,000 names were taken from the most popular names from 1937 through 2013 (250 unvoiced male, 250 voiced male, 250 unvoiced female, 250 voiced female). We did not simply extract the 250 most popular names per category as this would create an imbalance in frequency of name (i.e., the top 250 voiced male names are given more frequently than the top 250 unvoiced male names, and likewise the top 250 unvoiced female names are given more frequently than the top 250 voiced female names). To avoid any confound of frequency of names, we used an iterative random sampling method to match names on frequency. For instance, a highly popular unvoiced male name was randomly extracted and a voiced male name that was similarly frequent in usage was chosen to match it; this process was repeated until unvoiced and voiced names were perfectly matched on frequency. Thus, we sampled from these names to achieve a list of 250 popular voiced male names that were matched in frequency of usage with 250 popular unvoiced male names, $t(498) = .001$, $p > .99$. The same was done for 500 female names (250 voiced, 250 unvoiced), $t(498) = .001$, $p > .99$. Thus, we obtained a list of 500 popular male names, and 500 popular female names, half of each being voiced, and half unvoiced, with voiced and voiced names matched on frequency. These 1,000 names account for nearly the entirety of given names in the United States, capturing more than 70% of all given names from 1937 through 2013.

To maximize the power of our analyses, averaged masculinity ratings of the 1,000 names served as our dependent measure (i.e., an item-based analysis). Ratings of female names were reverse-scored (i.e., higher scores as more masculine) to calculate the average masculinity rating for each of the 1,000 names (500 male, 500 female).[5]

Results and Discussion

Because masculinity rating data were non-normal (Shapiro-Wilk's $W = .88$, $p < .001$), we fitted a linear mixed effect model (implemented with R-package lme4), entering the name's gender and whether it was voiced as fixed factors, and the name's frequency as a random factor, predicting how masculine the name was rated.

Importantly, the name being voiced (vs. unvoiced) predicted increased masculinity ratings, $b = 0.16$, $SE = .06$, $t(996) = 2.56$, $p = .01$. Unsurprisingly, the name being male (vs. female) predicted increased masculinity ratings, $b = 2.68$, $SE = .06$, $t(996) = 43.69$, $p < .02 \times 10^{-14}$. Entering both predictors and their interaction revealed there was no interaction between these factors, $b = 0.04$, $SE = .12$, $t(995) = 0.31$, $p = .76$ (mean masculinity: voiced male names = 5.27, unvoiced male names = 5.09, voiced female names = 2.56, unvoiced female names = 2.42).[6]

As before, we examined whether results held when only analyzing names beginning with consonants (87.69% of all names). Again, the name being voiced (vs. unvoiced) also predicted increased masculinity ratings, $b = 0.17$, $SE = .07$, $t(873) = 2.58$, $p = .01$. The name being male (vs. female) predicted increased masculinity ratings, $b = 2.63$, $SE = .07$, $t(873) = 39.36$, $p < .02 \times 10^{-14}$, and there was no interaction, $b = -0.08$, $SE = .14$, $t(872) = -0.58$, $p = .57$ (mean masculinity: voiced male names = 5.23, unvoiced male names = 5.09, voiced female names = 2.63, unvoiced female names = 2.42).[7]

In sum, voiced names, independent of whether they were a man's or woman's name, were rated as more masculine and unvoiced names were rated as more feminine. This finding thus extends the voiced name effect to gender stereotypes.

Study 4: Experimental Evidence From Novel Names

The studies thus far have clearly demonstrated a relationship between voiced phonemes and gender, with male names being more voiced, and female names being more unvoiced. This relationship can predict which names are assigned to which gender (even for names given to both genders), and which names, independent of the gender, are judged as feminine and masculine. The following studies examine the voiced gendered name effect experimentally. Study 4 next examined whether novel voiced and unvoiced names would be more likely assigned to males and females, respectively.

Method

Participant and design. Forty participants in a within-subjects design (63% men; $M_{age} = 29.68$ years, $SD = 10.12$) categorized 80 novel names as male or female (ostensibly from a foreign language; half voiced, half unvoiced).

Stimuli. A research assistant blind to experimental hypothesis randomly extracted 40 unique novel name stems, taken from a list of nonwords for lexical decision tasks (from Duyck, Desmet, Verbeke, & Brysbaert, 2004; e.g., anyin, epast, opaz). Stem selection was restricted to cases where names were pronounced with only two syllables. The stems were manipulated such that each stem was preceded once by a voiced phoneme, and another time with an unvoiced phoneme (e.g., Banyin, Panyin; Zepast, Sepast; Vopaz, Fopaz), for a total of 80 artificially created novel names to categorize (labeled in the current paper as novel name Set A). Preceding voiced letters [International Phonetic Alphabet sym-

[5] By computer programming error, one male name was not presented to participants, leaving a total of 999 names to analyze.

[6] To ensure the robustness of the mixed-effect model, we tested our model again using R-package hglm to implement the estimation algorithm for hierarchical generalized linear models. This model uses the scaled deviance for the goodness-of-fit test, and thus can handle non-normal distributions for varying coefficients, wherein degrees of freedom can be estimated from the expected deviance and number of parameters. This model yielded highly similar results: The name being voiced predicting increased masculinity ratings, $b = 0.16$, $SE = .06$, $t(603) = 2.58$, $p = .01$; the name being male increasing masculinity ratings, $b = 6.28$, $SE = .06$, $t(603) = 43.62$, $p < .02 \times 10^{-16}$; no interaction $b = 0.04$, $SE = .12$, $t(602) = 0.30$, $p = .76$.

[7] Again, using an alternate mixed-effect model (the hierarchical generalized linear model) revealed the same pattern of results when constricting analyses to only names beginning with consonants: the name being voiced predicting increased masculinity ratings, $b = 0.18$, $SE = .07$, $t(529) = 2.60$, $p = .01$; the name being male increasing masculinity ratings, $b = 2.63$, $SE = .07$, $t(529) = 39.30$, $p < .02 \times 10^{-14}$; no interaction $b = -0.08$, $SE = .14$, $t(528) = -0.58$, $p = .56$.

bols] were B [b], G [g], D [d], V [v], J [dʒ], and Z [z]. Preceding unvoiced letters were P [p], C [k], T [t], F [f], K [k], and S [s].[8]

Results and Discussion

Novel voiced names were categorized more often as male (M = 60.62%, SD = 14.07) than novel unvoiced names (M = 55.19%, SD = 13.06), $t(39) = 2.84$, $p = .007$, $d = .40$. Thus, when exposed to novel names, participants are more likely to think the name belongs to a male when voiced, and more likely belongs to a female when unvoiced.

Study 4 experimentally demonstrated the voiced gendered name effect. When the first phoneme in a novel name was voiced, it was more likely to be judged as belonging to a male, and when the first phoneme in a novel name was unvoiced, it was more likely to be judged as belonging to a female.

Studies 5a–5c: Novel Names and Hard and Soft Sounds

Study 5 sought to examine the mechanism that underlies these judgments. That is, what about voiced and unvoiced names seems to evoke masculinity and femininity, respectively? Recall that we argue that the vibration of the vocal cords during voiced phonemes—by modulating the air flow rather than letting it pass through unmodulated—is what makes voiced, relative to unvoiced, phonemes sound harder to the ear. We propose that this voiced effect is associated with gender. Indeed, prior work demonstrates that males are symbolically described as tough and "hard," whereas females are symbolically described as tender and "soft" (Slepian et al., 2011).

We propose that voiced versus unvoiced phonemes will sound harder to participants' ears. Perhaps voiced names are more likely to be given to males, and unvoiced names to females because voiced names sound relatively hard to the ear, whereas unvoiced names sound relatively soft to the ear.

We asked one group of participants to rate how hard versus soft the names used in Study 4 sounded to their ears (Study 5a); the stimuli were described to participants as words (not names) ostensibly from a foreign language. To test another potential symbolic relationship, another group of participants rated how rough versus smooth the words sounded to their ears (Study 5b). We asked a third group of participants to judge how masculine versus feminine each word sounded (Study 5c).

Study 5a

Method. Forty participants, recruited from Mechanical Turk (65% men; M_{age} = 33.55 years, SD = 10.13) were presented with the 80 randomly ordered novel names from Study 4 (novel name Set A), and asked to rate by key press how the words sounded. Instructions emphasized that participants should focus on how the word sounded to their ear, and they were asked to rate the word on a 7-point scale from sounding *soft* (1) to *hard* (7). Again, these names were composed of 40 stems, each appearing once with a voiced phoneme, and once with an unvoiced phoneme.

Results. Participants rated novel names beginning with a voiced phoneme as sounding harder (M = 4.19, SD = 0.60) than unvoiced names (M = 3.93, SD = 0.63), $t(39) = 3.74$, $p = .001$, $d = .42$.

Study 5b

Method. Forty participants, recruited from Mechanical Turk (70% men; M_{age} = 31 years, SD = 9.88) were presented with the 80 randomly ordered novel names from Study 4 (novel name Set A). Instructions emphasized that participants should rate how the words sounded to their ear as in Study 5a, and they were asked to rate by key press each randomly ordered word on a 7-point scale from sounding *smooth* (1) to *rough* (7).

Results. Participants rated novel names beginning with a voiced phoneme as sounding rougher (M = 4.10, SD = 0.64) than unvoiced names (M = 3.93, SD = 0.58), $t(39) = 3.39$, $p = .002$, $d = .28$.

Study 5c

Method. Forty participants, recruited from Mechanical Turk (60% men; M_{age} = 33.70 years, SD = 11.87) were presented with the 80 randomly ordered novel names from Study 4 (novel name Set A).[9] Instructions emphasized that participants should rate how the words sounded to their ear as in Studies 5a and 5b, and they were asked to rate by key press each randomly ordered word on a 7-point scale from sounding *feminine* (1) to *masculine* (7).

Results. Participants rated novel names beginning with a voiced phoneme as sounding more masculine (M = 4.29, SD = 0.46) than unvoiced names (M = 4.08, SD = 0.38), $t(39) = 3.05$, $p = .004$, $d = .50$.

Predicting Femininity/Masculinity Ratings

We next sought to examine a parallel mediational model, with unvoiced/voiced as a predictor of femininity/masculinity judgments, including soft/hard ratings and smooth/rough ratings as parallel mediators, and then second, examined the actual gendered frequency of the phonemes as an additional parallel mediator.

To conduct these analyses, which consider ratings as different variables (collected from independent samples of participants), we

[8] There are 14 phonemes in English that can occur at word onset and have contrasting phonemes that differ only in voicing; Voiced (letters followed by [IPA symbols]) vs. unvoiced: P [p] vs. B [b]; T [t] vs. D [d]; K (and sometimes C) [k] vs. G [g]; Ch [tʃ] vs. J [dʒ]; F [f] vs. V [v]; Th (as in thin) [θ] vs. Th (as in this) [ð]; S [s] vs. Z [z]. We did not match phonemes to their counterparts per each stem for Studies 4 and 5, but did match them for Studies 6 and 7.

[9] In each study, of Studies 5a through 5c, we included an a priori attention check. In the instructions participants were told that the 7-point scale ranged from 1 to 7, and they were to make their judgment by key press (using the numbered 1 to 7 keys). During each stimulus presentation, names were flanked by reminders of key pairings as in Study 4 (e.g., "1-feminine" and "7-masculine"). We suspected that for participants who did not read the instructions properly, they would interpret these as categorical judgments, rather than as a continuous scale (therefore not treating the scale properly, utilizing 2–6). Indeed, an additional 3 participants in Study 5b, and an additional 8 participants in Study 5c, failed this attention check. To keep sample sizes consistent across Studies 5a through 5c (given that these data were then combined for item-based analyses), for each study, after collecting 40 participants, we examined how many failed the attention check, and then collected that same number of participants to replace them given that we a priori decided to exclude participants who failed the attention check (i.e., not using the scale properly). Despite these additional participants not using the scales properly, including them in the analyses does not influence the patterns of results or significance.

conducted an item-based analysis. For all analyses, tests of multicollinearity indicated independence among the variables in each of the models, all variance-inflation factors <10, and all tolerances $> .10$ (Kline, 1998).

Sound symbolism mediator model. Because voiced names sounded harder and rougher to participants' ears, relative to unvoiced names (Studies 5a and 5b), we first tested a mediation model wherein soft/hard and smooth/rough judgments were parallel mediators between the independent variable of unvoiced/voiced and the dependent variable of femininity/masculinity judgments. We used a bootstrapping technique (with 5,000 iterations) to estimate the indirect effects (Hayes, 2009).

This analysis demonstrated that voiced versus unvoiced phonemes predicted increased judgments of masculinity through increased judgments of the names sounding harder versus softer, $M = .0904$, $SE = .0672$, 95% CI [.0027, .2838]. There was not a parallel significant indirect path through smooth/rough ratings, $M = .0051$, $SE = .0329$, 95% CI [−.0420, .1045].

Gendered phoneme frequency mediator model. Of the two ratings, we found evidence that soft/hard ratings mediated the effect of manipulated unvoiced/voiced phonemes on femininity/masculinity judgments. An alternative hypothesis, however, is that perhaps with repeated exposure to male and female names, through the ability to detect statistical regularities from that exposure, people might associate specific phonemes with genders simply because that association actually exists. Perhaps the greater proportion of voiced names belonging to males, and unvoiced names belonging to females, is an arbitrary association that systematically exists throughout the years.

One simple way to test whether an awareness of the statistical regularities of phoneme-gender associations are driving participants' judgments is to calculate how much each phoneme is associated with actual names by gender, and examine if per each stimulus, whether that mediates the effect of unvoiced/voiced phonemes on participants' femininity/masculinity judgments (i.e., if participants are using this statistical covariation to inform their judgments, then the true covariation would likely be a statistical mediator).

To calculate the gendered frequency of each phoneme used, we calculated (using the U.S. birth data set) the total frequency that both males and females have a name beginning with each phoneme used in Study 5. That is, the gendered frequency of each phoneme was calculated by summing how many of each of the 139,567,795 males (from Study 2's data set of births from 1937–2013) have a name beginning with the phonemes used in Study 5. We did the same for the 131,313,635 females in the same data set. Per each phoneme, we divided the number of males who have a name beginning with that phoneme by the total of males and females who have a name beginning with that phoneme, yielding an objective value of how gendered is each phoneme.

Using the same bootstrapping technique as above, we tested a mediation model, wherein the gendered phoneme frequency scores were also entered as a parallel mediator between the independent variable, unvoiced/voiced, and the dependent variable, femininity/masculinity judgments. Again, voiced (vs. unvoiced) increased masculinity judgments through increased hardness judgments, $M = .1052$, $SE = .0757$, 95% CI [.0020, .3136]. There were no significant indirect effects through either roughness judgments, $M = -.0055$, $SE = .0327$, 95% CI [−.1083, .0416], nor gendered phoneme frequency scores, $M = .0206$, $SE = .0233$, 95% CI [−.0065, .0985], indicating that after accounting for the significant mediating role of how soft/hard the names sounded, there was no unique statistically significant mediating roles for the other variables.

Discussion

Studies 4 and 5 provided experimental evidence that converges with the results of Studies 1 through 3. Categorization of novel names follows the same pattern as real names; voiced names are more often assigned to males and unvoiced names are more often assigned to females. This effect is mediated by how hard or soft the name sounds, consistent with associations that males have metaphorically "hard" traits and females have metaphorically "soft" traits.

Study 6: Novel Names and Audio Presentation

Study 6 created a new set of 144 novel names to ensure generalizability of the results. Moreover, names were presented aurally via a computerized voice to ensure that the results were contingent on how the names sounded, rather than how they appeared.

Method

Participants and design. Participants, recruited from Mechanical Turk ($N = 288$, 54% men; $M_{age} = 30.90$ years, $SD = 10.59$), categorized aurally presented novel names as male or female (between subjects, with either a computerized male voice, or female computerized voice). Participants were given a play button, and were allowed to play each of the randomly ordered 12 audio clips (from the randomly selected stimulus set of 12) as many times as they liked to arrive at a judgment (to parallel having text onscreen until a response was made as in Studies 4–5c). Participants were told that they would be presented with names from a foreign language (presented via audio), and that they were to make their best guess as to whether the name belongs to a male or a female.

Stimuli. A new set of artificially created novel names was created, and presented via audio clips (novel name Set B). These new stimuli matched each preceding unvoiced phoneme with its voiced counterpart. We utilized 12 consonants that can occur at word onset and have contrasting phonemes that differ only in voicing. These were [p] versus [b]; [t] versus [d]; [k] versus [g]; [tʃ] versus [dʒ]; [f] versus [v]; and [s] versus [z], which could be spelled (participants saw no spellings, but only heard audio clips) with beginning letters P versus B; T versus D; K (or C) versus G; Ch versus J; F versus V; and S versus Z.[10]

Additionally, stems were now fully crossed with preceding phonemes, such that 12 stems (alosh, alow, andir, antam, archick, elton, emav, endaz, olent, ontid, orbip, and umal) were preceded by each of the 12 phonemes (e.g., "palosh," "balosh,"

[10] As also described in Footnote 8, there is a final pair of contrasting phonemes θ and ð (the two *th* sounds). We did not utilize these, however, because to our knowledge, there are no names in the database of names used in Study 2 that begin with a Th that are pronounced with the θ (as in this) phoneme instead of the ð (as in thin) phoneme.

etc.) for a total 144 novel names pronounced by one of two highly natural synthesized voices (stems were chosen to approximate the frequency of vowels occurring after initial consonants in the name dataset used in Study 2). That is, rather than use text to present the names (as in Studies 5 and 6), we created audio clips that pronounced the names with two synthesized voices, one male, and one female. We used for the male voice, "Alex," the currently most natural synthetic speech available in English, available on the Mac OS X operating system (Henton, 2012), and for the female voice, a similarly natural synthesized female voice, "Victoria," also available on the Mac OS X operating system (Bellegarda, 2010).

With these new stimuli, (a) any effect of voiced versus unvoiced phonemes on judgments is not specific to any particular phoneme + stem pairing as phonemes and stems are fully crossed, (b) phonemes used are perfectly matched, with both each voiced and unvoiced variant represented by the six pairs of phoneme used, (c) these new aurally presented stimuli allowed us to confirm that any effect of manipulated voiced (vs. unvoiced) phonemes on gender categorization were based upon how the names sounded to participants, and thus (d) the effect of manipulated voiced (vs. unvoiced) phonemes was specific to how voicing makes those phonemes sound, rather than simply how the names look from reading text.

From the 144 novel names, 12 stimulus sets of 12 names were created, such that each set had one of every phoneme, and one of every word stem (i.e., each participant was exposed to each of the 12 word stems, and each of the 12 phonemes). We collected 12 ratings per each stimulus set (i.e., 12 participants), and per each voice gender, totaling to 288 participants (144 participants rating novel names pronounced by the synthesized male voice, and 144 participants rating novel names pronounced by the synthesized female voice).

Results and Discussion

A mixed-design ANOVA with voiced versus unvoiced (within-subjects) and voice gender (between-subjects) revealed a main effect of novel voiced (vs. unvoiced) names being judged more often as male (vs. female), $F(1, 286) = 21.92$, $p < .0001$, $d = .42$; voiced names were categorized more often as male ($M = 64.41\%$, $SD = 19.12$) than unvoiced names ($M = 56.31\%$, $SD = 19.02$). There was no main effect of synthesized voice gender, $F(1, 286) = 1.86$, $p = .17$, $d = .16$, nor an interaction, $F(1, 286) = 0.64$, $p = .42$, $d = .09$.

Study 6 demonstrated that the sound of voiced versus unvoiced phonemes influenced whether participants categorized names as male or female. The current study utilized audio clips, confirming that these effects are not based merely on text-based judgments, but instead how the names sound. Moreover, given the stimuli were composed of contrasting sets of phoneme pairs, with the otherwise same exact phoneme presented in its voiced and unvoiced form, and that word stems were fully crossed with phonemes, we can be confident that the manipulated *sound* of *voiced* versus *unvoiced* phonemes are driving participants' judgments, with voiced names being more likely judged as male, and unvoiced names being more likely judged as female.

Study 7: Audio-Presented Novel Names and Mediation by Hard/Soft Judgments

Study 7 sought to extend Study 6, and replicate the mediational evidence found in Studies 5a–5c, by asking participants to make soft/hard judgments, femininity/masculinity judgments, and familiar/foreign sounding judgments on the stimuli from Study 6 (novel name Set B). That is, we sought to explore whether, as in Studies 5a through 5c, with this new stimulus set, voiced (vs. unvoiced) phonemes would increase masculinity judgments through increased hard-sounding judgments, but not through other plausible factors.

Method

Participants and design. Study 7 asked 288 participants recruited on Mechanical Turk (52% men; $M_{\text{age}} = 32.77$ years, $SD = 10.92$) to rate the 144 aurally presented novel names on 7-point scales (across three judgment blocks), from *soft–hard*, *familiar–foreign* (to disguise experimental hypotheses), and *feminine–masculine*. The stimuli were described to participants as words ostensibly from a foreign language; there was no mention that they were names.

Stimuli. Novel names from Study 6 were rated in three judgment blocks, from *soft–hard*, *familiar–foreign*, and *feminine–masculine*. The familiar-foreign judgment block served two goals. First, it provided a block that temporally separated soft/hard judgments and feminine/masculine judgments, to make it less likely participants would base their latter ratings on the former ratings. Second, it provided a third judgment to disguise the experimental hypothesis, which was that soft/hard judgments would predict femininity/masculinity judgments (indeed, during debriefing no participant guessed this hypothesis). Third, it provided another possible mediator to test for the relationship between unvoiced/voiced and femininity/masculinity judgments. That is, perhaps whether the first phoneme is voiced may make a novel name sound more foreign (e.g., the voiced version of [s] is [z], which is a less usual phoneme to begin a name). Thus, to the extent that any particular phoneme makes a name sound more foreign (and this impacts femininity/masculinity judgments), we can examine whether over and above this relationship to foreignness, voiced (vs. unvoiced) phonemes predicts increased masculinity judgments through increased hardness judgments for how those names sound.

Results

To parallel Study 4's analysis, we first conducted three mixed-design ANOVAs with voiced versus unvoiced as a within subjects-factor, and gender of the synthesized voice as a between-subjects factor, with one ANOVA per each rating (soft/hard, familiar/foreign, and feminine/masculine).

Soft/hard judgments. The mixed-design ANOVA on soft/hard judgments revealed a main effect of voiced versus unvoiced, $F(1, 286) = 10.53$, $p = .001$, $d = .21$; novel voiced names were rated as sounding harder ($M = 4.27$, $SD = 0.88$) than novel unvoiced names ($M = 4.10$, $SD = 0.78$). There was no main effect of the gender of the synthesized voice, $F(1, 286) = 1.96$, $p = .16$, $d = .16$, nor interaction, $F(1, 286) = 0.31$, $p = .58$, $d = .07$.

Familiar/foreign judgments. The mixed-design ANOVA on familiar/foreign judgments revealed a main effect of voiced versus unvoiced, $F(1, 286) = 34.28$, $p < .0001$, $d = .36$; novel voiced names were unexpectedly rated as sounding more foreign ($M = 4.78$, $SD = 1.05$) than novel unvoiced names ($M = 4.40$, $SD = 1.10$). There was no main effect of the gender of the synthesized voice, $F(1, 286) = 0.33$, $p = .86$, $d = .02$, nor interaction, $F(1, 286) = 0.28$, $p = .60$, $d = .06$.

Feminine/masculine judgments. The mixed-design ANOVA on feminine/masculine judgments revealed a main effect of voiced versus unvoiced, $F(1, 286) = 66.74$, $p < .0001$, $d = .68$; novel voiced names were rated as sounding more masculine ($M = 4.64$, $SD = 0.88$) than novel unvoiced names ($M = 4.07$, $SD = 0.80$). Unlike in all prior analyses, however, there was also a main effect of the gender of the synthesized voice (manipulated *between* subjects), $F(1, 286) = 5.44$, $p = .02$, $d = .28$, whereby names pronounced with the male voice were judged as sounding more masculine ($M = 4.44$, $SD = 0.64$) than the same names pronounced with a female voice ($M = 4.28$, $SD = 0.54$). Critically, however, there was no interaction, $F(1, 286) = 0.18$, $p = .67$, $d = .05$.

Predicting femininity versus masculinity ratings. As in Study 5, we examined whether names pronounced with voiced (vs. unvoiced) phonemes predicted increased masculinity judgments through hardness judgments by considering average ratings as the dependent measure, and conducting an item-based mediational model. For all analyses, tests of multicollinearity indicated independence among the variables in each of the models, all variance-inflation factors <10, and all tolerances > .10 (Kline, 1998).

Sound symbolism mediator model. We first examined, using the same bootstrapping procedures as in Study 5, whether voiced (vs. unvoiced) names predicted femininity/masculinity judgments, through the sound symbolism rating of soft/hard, by testing a mediation model wherein soft/hard and familiar/foreign judgments were parallel mediators between the independent variable, unvoiced/voiced, and the dependent variable, femininity/masculinity judgments. A significant effect of names being voiced (vs. unvoiced) increasing masculinity judgments through increased hardness judgments was found, $M = .1009$, $SE = .0485$, 95% CI [.0100, .2014]. There was no significant indirect effect through familiar/foreign judgments, $M = -.0111$, $SE = .0213$, 95% CI [−.0587, .0279].

Gendered phoneme frequency mediator model. As discussed in Study 5, while this finding is consistent with the current hypotheses, another possibility is that merely because of an arbitrary male-voiced/female-unvoiced link, voiced (vs. unvoiced) names are rated as sounding harder because these phonemes are more associated with male names. This is perhaps unlikely given that when judging names on softness/hardness, participants were not told the audio clips should even represent names, but rather only that they were words from a foreign language. Still, as in Study 5, we tested this alternative hypothesis by reconducting the mediational analysis with the inclusion of the actual gendered frequency of each phoneme (i.e., per each phoneme used, the proportion of male vs. female names that begin with that phoneme). This second mediational model thus tests whether voiced (vs. unvoiced) names predicted femininity/masculinity judgments through the sound symbolism rating of soft/hard, over and above any mediating roles of both familiar/foreign judgments and the actual gendered frequency of the phonemes used.

A significant effect of names being voiced (vs. unvoiced) increasing masculinity judgments through increased hardness judgments remained, $M = .1001$, $SE = .0482$, 95% CI [.0100, .2002]. There were no significant indirect effects through familiar/foreign judgments, $M = -.0114$, $SE = .0213$, 95% CI [−.0591, .0267] nor gendered phoneme frequency scores, $M = .0235$, $SE = .0343$, 95% CI [−.0388, .0951], again indicating that after accounting for the significant mediating role of how soft/hard the names sounded, there was no unique statistically significant mediating roles for the other variables.

Discussion

As in Studies 5a through 5c, Study 7 demonstrated that voiced (vs. unvoiced) names predicted increased masculinity judgments through increased hardness judgments. Additionally, paralleling the earlier studies, we also did not find evidence for a model that would suggest the reverse direction of influence. That is, it might be that voiced names are rated as sounding harder from participants' awareness of statistical regularities of the voiced-male/unvoiced-female link. If this were the case, we would expect to see the objective gendered frequency of the phonemes mediating the influence of voiced (vs. unvoiced) phonemes on masculinity judgments over and above the mediating role of softness/hardness judgments; yet the reverse was the case.

Study 7 thus provides evidence that voiced (vs. unvoiced) novel names predict increased masculinity judgments through those novel names sounding harder. Indeed, several improvements to the stimulus set used in Studies 6 and 7 (relative to Studies 4–5c) support this suggestion. First, rather than present novel names via text, they were presented by audio clips. Second, stimuli were composed of contrasting phoneme pairs (for each unvoiced phoneme, the voiced phoneme used was exactly the same phoneme, but voiced). Third, word stems were fully crossed with phonemes. Taken together, these results demonstrate that, specifically, the manipulated sound of voiced, relative to unvoiced, phonemes led participants to judge those novel name as more masculine, through increased judgments of those names sounding harder.

Study 8: The Voiced-Name Effect in India

The studies thus far have focused on names given to individuals predominantly born in the United States. Crucially, however, we suggest that this phenomenon should extend to other cultures. Thus, in the next study, we examined the generality of the effect, recruiting Indian participants for Study 8.

To examine whether the voiced gendered name effect is limited to American names, we next examined Indian individuals' first names. To the current authors' knowledge there is no database of given names that captures all names across years in a given country, only datasets limited to highly popular names (e.g., the top 100 names, which are too few for reliable conclusions). Thus there was no other country database to use to parallel the methods used in Study 2 (which captured each given name on record, given to babies born in the U.S. from the past several decades).

Instead, we were able to leverage Mechanical Turk to provide access to another culture (as have others; e.g., Seih, Buhrmester, Lin, Huang, & Swann, 2013) given that the second largest population using Mechanical Turk after the United States is India (Paolacci, Chandler, & Ipeirotis, 2010).

Method

We adopted and extended the methodology used in Study 1 with Indian participants. Utilizing Mechanical Turk we recruited 1,000 Indian participants for a study ostensibly on the psychology of first names (M_{age} = 31.76 years, SD = 9.19; 62% men). After providing demographic information, participants were asked for their first name as participants were in Study 1. Similar to Study 1, the majority of the participants complied with this request (91%).

To also capture baby-naming patterns as per Study 2, we also asked participants to provide a name that they might give a son, and a daughter. Participants were asked if they were to have a son what would they name him, and if they were to have a daughter what would they name her (7% of participants did not provide both a name for a hypothetical son, and daughter, either by not entering text, or by misunderstanding the question, likely because of lower comprehension with the English language prompts; e.g., writing, "nice name," or "no daughter").

Results and Discussion

A chi-square analysis was conducted on the names, examining the contingency table of the number of participants' first names beginning with a voiced/unvoiced phoneme by the participants' reported gender. This analysis demonstrated a significant difference in the names beginning with voiced versus unvoiced phonemes across male and female participants (64.32% of voiced names being male, 35.68% of voiced names being female; 56.73% of unvoiced names being male, 43.27% of unvoiced names being female), $\chi^2(1, N = 911) = 5.21$, $p = .02$, $\varphi = .08$, (Table 4 for frequencies).

Moreover, the same pattern is found when participants were asked to provide names for sons and daughters. Names provided for a hypothetical son were more often voiced (M = 67.27%, SD = 46.95) than for a hypothetical daughter (M = 57.83%, SD = 49.41), $t(931) = 4.73$, $p < .0001$, $d = .20$ (see Table 4 for frequencies).

Given that some of the participants might actually have children, we also asked afterward whether for either name, *if* they had a son or a daughter, whether they wrote their own son's or daughter's name; (a) 160 participants wrote in their actual son's, and daughter's names, (b) 230 participants wrote in *either* their son's or daughter's name, and (c) the remaining 542 participants who completed the prompt provided new names for each the son and daughter prompt. Each subgroup of participants provided more voiced names for sons than daughters: (a) M_{son} = 64.38%, SD = 48.04; $M_{daughter}$ = 52.50%, SD = 50.00, $t(159) = 2.35$, $p = .02$, $d = .13$; (b) M_{son} = 70.43%, SD = 45.73; $M_{daughter}$ = 55.22%, SD = 49.84, $t(229) = 3.91$, $p = .0001$, $d = .32$; (c) M_{son} = 66.79%, SD = 47.14; $M_{daughter}$ = 60.52%, SD = 48.93, $t(541) = 2.40$, $p = .02$, $d = .24$ (see Table 4 for frequencies of each group).

Indian individuals with names from languages spoken in India demonstrate a similar pattern of voiced names being more likely given to males, and unvoiced names more likely given to females. Of the many languages spoken in India, each uses a different alphabet than English, and these languages are quite remote from English, having diverged from a common Indo-European language ancestor approximately 7,000 years ago (Gray & Atkinson, 2003). Thus, with access to a large sample from another distinct culture, India, we find evidence suggesting that the current results are not specific to American names and participants.

Study 9: Novel Names in India

As another test of whether the current results are limited to American culture, we also examined whether Indian individuals would categorize novel names as more likely male when beginning with a voiced phoneme, and female when beginning with an unvoiced phoneme. To examine this we simply had Indian participants participate in Study 4's procedure.

Table 4
Study 8 Analysis of Indian Participants' Names and Given Names to Sons and Daughters

Variable	Voiced	Unvoiced	Total
Indian participants' names			
Male	366 (64.32%)	194 (56.73%)	560
Female	203 (35.68%)	148 (43.27%)	351
Total	569	342	911
Actual combined with hypothetical sons and daughters			
Male	627 (53.77%)	305 (43.70%)	932
Female	539 (46.23%)	393 (56.30%)	932
Total	1,166	698	1,864
Actual sons and daughters			
Male	103 (55.08%)	57 (42.86%)	160
Female	84 (44.92%)	76 (57.14%)	160
Total	187	133	320
Actual (hypothetical) son and hypothetical (actual) daughter			
Male	162 (56.06%)	68 (39.77%)	230
Female	127 (43.94%)	103 (60.23%)	230
Total	289	171	460
Hypothetical sons and daughters			
Male	362 (52.46%)	180 (45.69%)	542
Female	328 (47.54%)	214 (54.31%)	542
Total	690	394	1,084

Method

Participants and design. One hundred Indian participants (71% men; M_{age} = 31.37 years, SD = 9.16) were recruited using Mechanical Turk, and participated in a procedure identical to Study 4, whereby they were randomly presented with 80 names (novel names Set A) ostensibly from another language, and asked to categorize them as likely belonging to a male or female.

Stimuli. Participants categorized the novel names from Study 4 as male or female. The proportion of names categorized as male (vs. female) was calculated for the 40 names beginning with voiced phonemes, and the 40 names beginning with unvoiced phonemes.

Results and Discussion

A paired t test demonstrated that voiced names were categorized more often as male (M = 55.10%, SD = 12.42) than unvoiced names (M = 51.75%, SD = 12.94), $t(99) = 3.13$, $p = .002$, d = .26.

Indian individuals both showcase the same voiced-male/unvoiced-female patterns in their names, and also are more likely to categorize novel names as belonging to a male when beginning with a voiced phoneme, and conversely, more likely to categorize novel names as belonging to a female when beginning with an unvoiced phoneme.

It is important to note that it is possible that the tendency for the current Indian sample to categorize novel voiced (vs. unvoiced) names as more often male could be driven by familiarity with the English language and a function of transliteration, or familiarity with American names given participant's participation in Amazon's Mechanical Turk, which is based in the U.S. That said, we also did find evidence for the voiced gendered name effect with Indian participant's actual names (and hypothetical names), which were traditional Indian names, rather than American names. Studies 8 and 9 should not be taken to suggest that the voiced gendered name effect would be seen in all languages of the world (this awaits future research),[11] but rather that the current results do not seem to be a peculiarity specific to the English language or American's names.

Study 10: Expecting Parents

Study 10 manipulated the remaining phonemes not yet experimentally manipulated (see Table 1), and also sought to explore the present effects in a population currently choosing a name for their baby, expecting parents.

Method

Participants and design. Pregnant women, or their partners (N = 100; M_{age} = 29.29 years, SD = 5.16; 54% women), in a within-subjects design, were asked to decide whether they would give a series of novel names to either a baby boy or girl.[12] They judged 102 novel names (a third set of novel names; Set C).

Stimuli. As in the prior studies, a stem appeared once with an unvoiced phoneme and once with a voiced phoneme. A total of 51 stems were used in the current study, 40 from the prior studies, and 11 additional stems drawn from the same source (the number of stems necessary to accommodate the new phonemes, so that across all experiments, all phonemes were tested). The artificially created novel names thus began with the following letters: voiced phonemes, A, B, D, E, G, I, J, L, M, N, O, R, U, V, W, Y, and Z; unvoiced phonemes C, Ch, F, H, K, P, Qu, S, Sh, and T (the letter X was not used given that were it to begin a novel word, participants would likely be unsure as to how to pronounce it).

Results and Discussion

Expecting parents judged that novel voiced names should more often be given to a boy (M = 69.77%, SD = 13.50) than novel unvoiced names (M = 58.34%, SD = 12.74), $t(99) = 2.66$, p = .009, d = .53. Thus, the current results extend to a population that is actually choosing a name for their baby. Expecting parents are more likely to judge a novel voiced name as appropriate for a baby boy, and a novel unvoiced name as appropriate for a baby girl.

Study 11: Moderation by Gender Stereotype Endorsement

The prior studies demonstrate the voiced gendered name effect, both experimentally and through archival analyses, across the U.S. and India, and also with expecting parents. Although the effect of voiced phonemes sounding harder than unvoiced phonemes is a perceptual phenomenon caused by the vibration of the vocal cords, modulating the air flow that is expelled in pronouncing the phoneme, the endorsement that men are hard or tough and women are soft or tender might be less universal because the symbolic hard-soft dimension shares commonality with traditional gender stereotypes. The influence of voiced versus unvoiced (i.e., "hard" vs. "soft" sounding) phonemes on gender judgments might be moderated by endorsement of traditional gender stereotypes associated with the metaphorical hard/soft dimension.

The goal of Study 11 was to examine whether the present effects would be moderated by endorsement of gender stereotypes. We predicted that the more individuals endorsed traditional stereotypes associated with the hard/soft dimension, the more they would indicate "hard" and "soft" sounding names should be given to "males" and "females," respectively.

Method

Participants and design. One hundred participants recruited on Mechanical Turk (M_{age} = 35.02 years, SD = 12.83; 54%

[11] Interestingly, given that throughout the evolution of languages and divergences of languages from their common ancestors, "phoneme shifts" have occurred, where one phoneme has become another, including voiced phonemes becoming unvoiced, and unvoiced phonemes becoming voiced. If older, traditional names pre-dating this phoneme shift are still used in a language after a phoneme shift, perhaps this would interfere with finding the voiced gender name effect with natural names in that language even despite perceived relationships between voiced/unvoiced and hard/soft with masculine/feminine.

[12] A study was advertised online for women or their partners who were pregnant. The final question of the study asked participants whether they or their partner were truly pregnant, or whether they simply took the study despite not qualifying for it (honesty was encouraged so that the participants could help the researchers). Nine such participants admitted that they (or their partner) were not pregnant, and these participants were thus replaced.

women) participated in a within-subjects design. Participants were asked to judge the masculinity-femininity of novel names as sounding *feminine* (1) to *masculine* (7). Subsequently, they completed two measures of stereotype endorsement, a *descriptive* measure of stereotype endorsement and a *prescriptive* measure of stereotype endorsement.

Stimuli. The categorization task consisted of the 102 novel names, presented in a random order, from Study 10 (novel names Set C). Participants were asked to judge novel names as sounding *feminine* (1) to *masculine* (7). The average masculinity rating was calculated for the 51 names beginning with voiced phonemes, and the 51 names beginning with unvoiced phonemes.

Gender stereotype endorsement. After the categorization task, participants completed two measures of gender stereotype endorsement. The first, a *descriptive* measure of stereotype endorsement, was adapted from Diekman and Eagly (2000). This measure asked participants how the average man and woman compare to each other on a list of characteristics (presented in a random order): competitive, daring, adventurous, aggressive, rugged, physically strong (stereotypical of male), and affectionate, sympathetic, gentle, sensitive, cute, petite (stereotypical of female) from 1 (*men extremely more*) to 7 (*women extremely more*). The first set was reverse scored, and a mean was taken, with higher numbers indicating more support for descriptive gender stereotypes ($\alpha = .90$). The measure was adapted from its original source (i.e., only the above listed items were used from a larger list of items). This was done to choose items that most faithfully captured gendered stereotype content that resembles the metaphorical hard-soft distinction. That is, we assessed gender stereotype endorsement to specifically measure the individual's symbolic association between male/female and metaphorically hard/soft traits. Thus, only the six most relevant traits per male and female were chosen (see Slepian, Rule, & Ambady, 2012, Study 1 for a linguistic analysis of the hard/soft metaphor applied to social categories).

An additional measure followed of societal *prescriptive* stereotype endorsement, adapted from Prentice and Carranza (2002). As before, only the six traits per gender that best captured the metaphorical hard to soft trait distinction were chosen to assess the symbolic association between male/female and hard/soft. This measure, however, asked participants how desirable it is in American society for men and women to possess a list of characteristics (presented in a random order): sensitive, friendly, cooperative, yielding, warm and kind, emotional (stereotypical of women), and self-reliant, ambitious, rebellious, assertive, aggressive, stubborn (stereotypical of men) from 1 (*very undesirable*) to 7 (*very desirable*). Participants completed the items twice, once for men (*very undesirable for men* to *very desirable for men*), and once for women (*very undesirable for women* to *very desirable for women*), with blocks randomly ordered. A mean was taken for stereotypical items, and nonstereotypical items, and support for the latter was subtracted from the former, yielding an index with higher numbers indicating more support for prescriptive gender stereotypes ($\alpha = .82$).

Results and Discussion

Participants rated novel names beginning with a voiced phoneme as sounding more masculine ($M = 4.35$, $SD = 0.46$) than unvoiced names ($M = 4.17$, $SD = 0.46$), $t(99) = 4.77$, $p < .0001$, $d = .39$.

We also examined whether either index of gender stereotype endorsement associated with the metaphorical hard/soft dimension predicted the strength of the effect. We subtracted the number of male categorizations of unvoiced names from the number of male categorizations of voiced names, thus creating an index reflective of the voiced-male/unvoiced-female association, with higher numbers indicating categorizing more voiced names as male, and more unvoiced names as female. Regression analyses revealed that descriptive stereotype endorsement significantly predicted the effect, $b = .11$, $SE = .05$, $t(98) = 2.25$, $p = .03$, whereas prescriptive stereotype endorsement had only a marginal effect, $b = .05$, $SE = .03$, $t(98) = 1.68$, $p = .10$.

The prior studies demonstrated that manipulated voiced (vs. unvoiced) phonemes increase masculinity judgments, through the novel names sounding harder. That is, the prior studies demonstrated mediation by the judged sound. This study tested whether the voiced gendered name effect would be moderated by the symbolism of that sound (i.e., whether endorsement of traditional gender stereotypes related to the hard/soft dimension would moderate the influence of manipulated voiced/unvoiced phonemes on masculine/feminine judgments). Indeed, masculine/feminine judgments were moderated by endorsement of these descriptive traditional gender stereotypes. This suggests that the belief that men and women have different traits moderates the influence of voiced/unvoiced phonemes upon masculine/feminine judgments. In contrast, we did not find significant moderation by whether people believed it was desirable to possess such gender-typed traits. Thus, it is possible that an awareness of traditional gender stereotypes is what moderated the current effect, rather than endorsement of those stereotypes. However, such a conclusion must be made with caution. The specific items used for these two measures were different, and thus perhaps are cofounded by stereotype content. More generally, Study 11 demonstrates moderation by gender stereotype endorsement. Indeed, reconducting the analyses with an average of the descriptive and prescriptive stereotype endorsement measures reveals that this averaged stereotype endorsement measure predicted categorizing more voiced names as male and more unvoiced names as female, $b = .11$, $SE = .04$, $t(98) = 2.39$, $p = .02$. Thus, the manipulated sounds of phonemes (voiced vs. unvoiced) influenced gendered judgments to the extent that individuals symbolically associated hardness or softness with the gender categories (male vs. female).

General Discussion

Eleven studies examining the initial phonemes of names provided consistent evidence that voiced names (i.e., those pronounced with the vibration of vocal cords) are given more frequently to males, and unvoiced names (i.e., those pronounced without the vibration of vocal cords) are given more frequently to females. This was seen in archival studies of people's names, including the analysis of over 270 million individuals' names, as well in experiments using three different large sets of novel names. These effects occurred regardless of whether names were presented via text or audio. The effects were present across two cultures (the U.S. and India), and were present in both actual baby naming as well hypothetical baby naming, including a study with expecting parents as participants.

We also found evidence for our proposed sound symbolism account. Voiced names sound more "hard", whereas unvoiced names sound more "soft," and "hard" sounding names are judged as more masculine, whereas "soft" sounding names are judged as more feminine. This mediational evidence provides a carefully controlled and theory-driven examination of the psychological underpinnings for how names might be born and maintained through sound symbolism.

Our final study found these effects were moderated by endorsement of traditional gender stereotypes. With increasing endorsement that men have symbolically "hard" personalities and women have symbolically "soft" personalities, individuals were more likely to categorize voiced names as masculine and unvoiced names as feminine.

Implications for Sound Symbolism

The current work presents a new domain and new methodology to test sound symbolism hypotheses. There has been debate as to whether sound symbolism actually regularly occurs throughout language (e.g., de Saussure, 1916; Gasser, 2004; Monaghan, Christiansen, & Fitneva, 2011; Köhler, 1929; Ramachandran & Hubbard, 2001; Westbury, 2005). Our analysis of more than 270 million individuals' names and three different large experimental sets of novel names provide consistent evidence that voiced names are more often given to males, and unvoiced names are more often given to females.

Every person has a name, whether chosen by someone else (e.g., parents) or oneself. Patterns of baby naming (particularly in the U.S.) have been closely tracked, and the first usages of new names in the baby name canon can easily be traced, unlike what is often the case for other common words. Given the regularity with which names are born and maintained throughout the decades, we can look to how people choose names for people as a potentially fertile area for sound symbolism. With high accuracy, people are able to determine a person's gender from his or her name; it is thus clear that some names are conventional for males, and others for females.

We believe that names become conventional for males and females not by mere randomness, but through their sounds. We proposed that part of gender-naming conventions are a result of people preferring to give "male sounding" names to males and "female sounding" names to females. We also directly link this effect to sound symbolism through the aural experience of hardness and softness. Men are symbolically seen as having "harder" personalities and behaviors, and women are seen as having "softer" personalities and behaviors (Slepian et al., 2011; see also Broverman et al., 1972; Prentice & Carranza, 2002). Here we postulated that voiced phonemes will sound harder to the ear as a consequences of the vocal cords vibrating during the pronunciation of a phoneme (modulating the flow of air), whereas unvoiced phonemes will sound softer to the ear as a consequence of unmodulated air flow (i.e., no vibration during the pronunciation of a phoneme, but rather a simple breath of air). We found that this correspondence between males and voiced phonemes with hardness, and females and unvoiced phonemes with softness predicts the voiced gendered name effect.

This finding opens up an expansive domain for sound symbolism research. What determines how people choose names for other people? People name people with sounds that symbolically represent their social categories.

The current work not only provides a new domain to test sound symbolism hypotheses, but new methods as well. The current research examined the nature of the link between voiced names and gender by examining mediation through the postulated sound, and moderation by the postulated symbolism. We found that when examining two different large sets of novel names, when the same stem was voiced, it sounded harder, and the more hard it sounded, the more masculine it was judged. Compared with unvoiced names, voiced names seemed more masculine rather than feminine because they sounded harder rather than softer. As a result of this mediational evidence, we demonstrated that the sound that symbolizes the social category *mediates* the influence of the manipulated phonemes (voiced vs. unvoiced) on judgments of masculinity/femininity. Future sound symbolism work could test for mediation by sound ratings to more precisely test sound symbolism hypotheses.

Additionally, the current work found moderation by support for the stated symbolism of the sound. Although the effect of voiced phonemes sounding harder is a perceptual phenomenon caused by modulated airflow, relative to the softer, breathier sound of unmodulated airflow, we do not believe it is universal for people to endorse the idea that men are symbolically harder or more tough, and women symbolically softer or more tender. In support of this idea, we found that endorsement of traditional gender stereotypes (e.g., men as tough, women as tender) increased whether voiced versus unvoiced phonemes led those individuals to categorize names as masculine versus feminine. This finding adds to recent work demonstrating that endorsement or knowledge of a metaphor is necessary to see metaphorically-based influences of sensorimotor processes on judgments (Slepian, 2015).

An alternative explanation for the current results could discount the evidence for mediation by rated sound, and moderation by associated symbolism by proposing that polarity correspondence (see Lakens, 2012) better explains the current effects than does sound symbolism. This hypothesis is that (a) voiced phonemes are more common than unvoiced phonemes and thus they are perhaps marked (i.e., the more salient kind of phoneme), and (b) because male (vs. female) is the default, it might also be marked; therefore (c) if both variables have this asymmetrical polarity (one end of the continuum being marked), an association between these variables could be the result of a polarity correspondence. Additional analyses did not, however, support this alternative explanation (see the Appendix for analyses and elaborated explanation of this alternative explanation).

In sum, the current studies are the first sound symbolism results to test both the postulated mediation by sound ratings, and moderation by the extent to which people believe those sounds symbolize the associated category. Future sound symbolism work should not only test for mediation by the sound qualities of the phonemes being examined, but also moderation by how much people associate those sound qualities symbolically with the category being studied.

Implications for Person Perception

We found that the first milliseconds of the sound of a name being pronounced influences categorical judgments of male and female, and continuous judgments of masculinity and femininity. This influence might extend to how people are perceived more generally. For instance, when a sex-ambiguous face is given a male name, people are more likely to categorize it correspondingly as male than when given a female name (Huart, Corneille, & Becquart, 2005). Perhaps even a simple phoneme that begins a word can sway how a gender-ambiguous face is categorized, both the eventual categorical judgment, but also how the face is processed across time (e.g., Freeman & Ambady, 2009).

In making a social judgment, a person must integrate multiple sources of information, across time. For instance, when exposed to a person that is eventually categorized as male, the categorization does not entail a simple activation of a "male" semantic category, but rather, multiple categories can be partially and simultaneously active (e.g., "female," "male"), and these activations can change and evolve over time before stabilizing on a final person construal (Freeman & Ambady, 2009). Multiple cues can weigh in on this process as it unfolds over time. For instance, in categorizing a face by gender, the pigmentation of skin exerts an influence sooner than does the morphology of a face, during the milliseconds it takes to categorize the face (Freeman & Ambady, 2011b).

Prior work has demonstrated that vocal pitch can also influence how a face is processed. For instance, exposure to a slightly sex-ambiguous male face leads to a simultaneous activation of opposing female and male categories, which dynamically compete until the face is eventually categorized as male (Freeman & Ambady, 2011a). The initial attraction toward categorizing the slightly feminine male face as (incorrectly) female is heightened when the face is paired with a high-pitched male voice, relative to a low-pitched male voice (Freeman & Ambady, 2011a). In other words, audition from hearing vocal pitch and vision from face exposure are dynamically integrated across time to arrive at a social categorical judgment. We might find that exposure to phonemes as voiced or unvoiced might similarly dynamically weigh in on the person perception process, influencing how faces are perceived, and how people arrive at social categorical judgments.

Moreover, motivational states, expectations, cultural knowledge, and stereotypes can all also dynamically weigh in on the person perception process, including how perception unfolds across time (Freeman & Ambady, 2009). For example, racial prejudice leads perceivers to judge an angry (vs. happy) face as more often Black (Hugenberg & Bodenhausen, 2004), and this influence might extend dynamically over time (Freeman & Ambady, 2009). Perhaps, then, we could see a similar effect of gender stereotypes on perception of names. For instance, with greater endorsement of gender stereotypes, perceivers might judge male names as sounding harder and female names as sounding softer. Future work could thus explore how gender stereotypes and the processing of names' phonemes dynamically interact to influence the social–cognitive process.

Future work could also explore whether these effects are different in strength when actually pronouncing the names, hearing the names pronounced, or simply reading the names (which produces automatic subvocal pronunciation; Topolinski, Lindner, & Freudenberg, 2014; Topolinski & Strack, 2009). Moreover, future work could code all the phonemes within a name to examine whether the current effects are particular to the first phoneme, or whether there is something more akin to a ratio-based effect (i.e., where the higher ratio of voiced to unvoiced phonemes predicts the gender of names).

Along the same lines, these effects could shape face learning and memory (e.g., Lea, Thomas, Lamkin, & Bell, 2007; Pantelis, van Vugt, Sekuler, Wilson, & Kahana, 2008). Perhaps because of a congruency between voiced phonemes and male names, and unvoiced phonemes and female names, male faces might be better remembered when having voiced names, and female faces might be better remembered when having unvoiced names, because of more fluent processing of voiced male names and unvoiced female names. Additionally, these congruencies could shape attitudes (as found in other domains; e.g., Topolinski et al., 2014). People who endorse traditional gender stereotypes might judge voiced male names and unvoiced female names more favorably, relative to unvoiced male names and voiced female names, respectively.

Implications for Person Naming

When a baby is born, one needs to provide it a name. One might give their child a name that is highly popular or highly unusual, a classic name or a brand new name, one that is typical for the baby's sex or one that is atypical. What influences how a parent chooses a name from the universe of names? Of course, a host of qualities about parents' traits and contexts will influence this decision. Yet, on the whole, that some names are gender-typical and others atypical for a gender already points to likely the most prominent influence upon one's choice: convention.

There have been numerous studies of how naming conventions change. For instance, Barry and Harper (1982) noticed an intriguing pattern of how names become relatively gender neutral. They proposed that because of differences in social status attributed to men relative to women in a male dominated-society, male names are perceived as more prestigious. Consequently, they suggested that parents will sometimes choose a conventional male name for a baby girl. They suggested that with increased frequency of a conventionally male name given to females, fewer parents might be then inclined to give that specific name to a baby boy, pushing the scales toward the name becoming less conventionally male and more gender neutral. Eventually, they suggest that as certain names become more gender neutral, parents are even more disinclined to give those names to baby boys, leading those names to eventually become conventionally female (a host of names that were initially conventional for males became gender neutral to eventually become conventional for females, e.g., Courtney, Lindsay, Meredith).

There are other trends in naming baby boys and girls. For example, female names come in and go out of fashion much more quickly than do male names (Lieberson & Bell, 1992). One possible explanation is that an old-fashioned name might bring to mind thoughts antithetical to youth, and parents might purposefully avoid such "old" sounding names for baby girls compared with boys (e.g., compare Mildred with Thomas). Which names do become popular can be driven by the media, but also by simple exposure to names within one's social network (e.g., see Centola & Baronchelli, 2015). Recent work demonstrates that name popularity, more generally, can drive parents' choices for naming babies. For instance, a name's momentum, that is, its growth in popularity over the last few years makes a name more attractive; parents are more likely to give names to babies that have grown in popularity in recent years (Gureckis & Goldstone, 2009). Likewise, parents are less likely to give names to babies that have become less popular in recent years (Gureckis & Goldstone, 2009). Like particular fashion trends, it seems a name that grows quickly in popularity can only become so popular before its momentum slows down, and the name eventually loses its popularity.

These studies exploring how names become popular are exploring cultural evolution (in the domain of baby naming). The current work suggests a new avenue to examine this cultural evolution. For instance, perhaps we might be able to predict which names become popular across time, depending on whether they are voiced or unvoiced (i.e., depending on sound symbolic correspondence). Giving voiced names to males, and unvoiced names to females, might be more common in time periods where people support traditional gender roles, and less common in periods where people sought to actively contest traditional gender roles. When new names are introduced, perhaps their likelihood to become popular depends on being consistent with the voiced gendered name effect. Parents' ideology might predict whether they name babies in a manner consistent with the voiced gendered name effect. We might find regional differences in the effect, and possibly even that having voiced versus unvoiced names might have implications for life outcomes (as has been found for easy vs. difficult to pronounce names; Laham et al., 2012). To add to the growing interest in understanding which names become popular, we suggest sound symbolism can provide another fruitful paradigm to examine name popularity and trends, and cultural evolution more generally.

Conclusion

By examining a ubiquitous feature of people—everyone has a given name—the current studies offer a new approach to studying sound symbolism and provide new insights into the nature of naming and language. We found that, phonetically, people give names to people that symbolically resemble their social category—they assign names that symbolically represent stereotypes associated with the social category. The current research identifies a basic reality of name giving, whereby certain names seem more appropriate for males and others for females. Whether vocal cords vibrate during the pronunciation of a given name—producing a harder sound relative to the softer sound of unmodulated airflow—predicts which names are assigned to which gender.

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Appendix

Supplementary Analyses

First Questions Asked About a Newborn

We could only locate one article testing the first questions people ask of a newborn (Intons-Peterson & Reddel, 1984), and thus conducted a study to also examine this question. Participants (N = 100, 65% male; M_{age} = 33.55 years, SD = 10.13) were asked to imagine that someone they knew just had a baby, but that the participant did not know anything about the baby. What are the first two questions they would ask? Of the first question they would ask, 55% asked first about the sex of the baby, 27% the name of the baby, 8% the age of the baby, 7% the weight or health of the baby, and 3% other. Of the second question they would ask, 33% asked about the name, 27% asked about the weight or health of the baby, 14% asked about the age of the baby, 10% asked the parent a question (e.g., "How are you feeling?"), 5% asked the baby's sex, and 6% asked something other. In sum, the two most common questions asked are the baby's sex and the baby's name.

Polarity Correspondence as an Alternative Explanation?

One alternative explanation for the correspondence between voiced and unvoiced phonemes and male and female names is a polarity correspondence. That is, because voiced phonemes are more common than unvoiced phonemes (e.g., in conversational English, 64.73% of consonants are voiced, and 35.27% are unvoiced; Mines, Hanson, & Shoup, 1978)—voiced phonemes could be considered the default. Other work shows that for gendered social categories, male is the default (e.g., Johnson, Iida, & Tassinary, 2012; Lick & Johnson, 2014). Because both categories (voiced/unvoiced, male/female) might have an asymmetry, in which one category is the default a relationship between the two could be the result of this polarity correspondence (see Lakens, 2012).

A test that would cast doubt on this hypothesis would be to compare names with highly common unvoiced phonemes, and with highly uncommon voiced phonemes, and ideally the phonemes would consist of a contrasting pair. Indeed, there is such a pair of phonemes to test. The unvoiced phoneme [s] is the third most likely consonant phoneme to begin a word and its voiced counterpart, [z], is the least likely consonant phoneme to begin a word (Mines et al., 1978). We thus re-conducted Studies 1 and 2 analyses, constricting analyses to only these two phonemes (recall when comparing counts, [s] names are more common than [z] names).

In Study 1, men were more likely to have name beginning with [z], and women beginning with [s]: men [100% of [z] names vs. 35.19% of [s] names (4 vs. 19 men)]; women (64.81% of [s] names vs. 0% of [z] names (35 vs. 0 women), $\chi^2(1, N = 58) = 6.54$, p = .01, Cramér's φ = .34 (this data consists of only 30 *unique* names, and thus too few to conduct inferential statistics on unique names, but the pattern is the same; men more [z] (1 male name, 100% of [z] names) than [s] (8 male names, 27.59% of [s] names), and women more [s] (21 female names, 72.41% of [s] names) than [z] (0 female names, 0% of [z] names).

In Study 2, boys were more likely to be given a name beginning with [z], and girls beginning with [s]: boys [69.27% of [z] names vs. 33.95% of [s] names (841,669 vs. 6,879,993 boys)]; girls [66.05% of [s] names vs. 30.73% of [z] names (13,382,638 vs. 373,306 girls)], $\chi^2(1, N = 21{,}477{,}606) = 621{,}014.19$, $p < .001 \times 10^{-300}$, φ = .17. Effects held when examining only the 8,798 unique names, with boy names more likely beginning with [z], and girl names with [s]: boy names [40.66% of [z] names vs. 23.55% of [s] names (616 vs. 1,715 boy names)]; girls [76.45% of [s] names vs. 59.34% of [z] names (5,568 vs. 899 girl names)], $\chi^2(1, N = 8{,}798) = 188.57$, $p < .04 \times 10^{-41}$, φ = .15. Finally, examining the 854 unique [s] and [z] names given to at least one boy and one girl revealed that the name being voiced (vs. unvoiced) predicted the proportion that the name was given to boys (vs. girls), b = .18, $t(852) = 5.11$, $p = .04 \times 10^{-5}$.

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