

Cross-linguistic and language-specific sound symbolism: Pokémonastics

Stephanie S Shih^a; Jordan Ackerman^b; Noah Hermalin^c; Sharon Inkelas^c; Hayeun Jang^a; Jessica Johnson^a; Darya Kavitskaya^c, Shigeto Kawahara^d; Miran Oh^a; Rebecca L. Starr^e; Alan Yu^f

^aUniversity of Southern California; ^bUniversity of California, Merced; ^cUniversity of California, Berkeley; ^dKeio University; ^eNational University of Singapore; ^fUniversity of Chicago

Corresponding author: Stephanie S Shih, shihs@usc.edu

The cross-linguistic prevalence of sound symbolism raises key questions about the universality versus language-specificity of sound symbolic correspondences. One challenge to studying cross-linguistic sound symbolic patterns is the difficulty of holding constant the real-world referents across cultures. In this study, we address the challenge of cross-linguistic comparison by utilizing a rich, cross-linguistic dataset drawn from a multilingual entertainment franchise, Pokémon. Within this controlled universe, we compare the sound symbolisms of Pokémon names (*pokemonikers*) in six languages: Japanese, English, Mandarin, Cantonese, Korean, and Russian. Our results show that the languages have a tendency to encode the same attributes with sound symbolism, but crucially also reveal that differences in sound symbolism are rooted in language-specific structural and lexical constraints.*

Keywords: sound symbolism; iconicity; names; onomastics; phonology; corpus linguistics; cognitive science; English; Japanese; Mandarin; Cantonese; Russian; Korean; translation; localization

1 Introduction

A core assumption about the design of human language is the arbitrariness of the sign, which holds that no intrinsic relationship connects linguistic form (‘the signifier’) and its meaning or function (‘the signified’) (e.g., Saussure 1915; Hockett 1959). A house-trained pet, for example, is arbitrarily symbolized by the sequence of phones that make its name—say, [kæt] in English or [ológbò] in Yoruba: no feline attribute necessarily connects to these phonetic representations, nor can a feline attribution necessarily be predicted from either series of phones. Arbitrariness allows human languages immense expressive range.

Languages, however, also exhibit patterns of non-arbitrariness, in which form more directly corresponds to meaning or function (noted as early as e.g., Plato’s *Cratylus*; see also Jespersen 1922:395ff). This ‘natural’ linkage between sound and meaning—*sound symbolism* being a cover term for non-arbitrariness—occurs across the world’s languages (e.g., Sapir 1929; Hinton et al. 1994; for recent surveys, see Spence 2011; Dingemanse et al. 2015; Lockwood & Dingemanse 2015; Sidhu & Pexman 2018). For example, English and Korean onomatopoeic examples are given in (1), where the words clearly mimic the sounds that they name.

* Acknowledgements to undergraduate RAs Alison Orgun, Max Fennell-Chametzky, and Katherine He; graduate RAs Maria Whittle, David Parker, Tianxiao Wang; and Russian language consultants Seva Chapnin and Villi Gaaz. Thank you to audiences at USC, UC Berkeley, UC Irvine, Michigan, SCAMP 2017, LSA 2018, and Pokémonastics 2018 for discussion on various portions of this research.

- | | | | |
|-----|---------------------|-----------------------------------|---------------------------|
| (1) | English | Korean | |
| | a. <i>tick tock</i> | <i>ttok ttak ttok ttak</i> (똑딱똑딱) | ‘sound of clock ticking’ |
| | b. <i>ding dong</i> | <i>ting tong taeng</i> (딩동댕) | ‘sound of a ringing bell’ |
| | c. <i>hehehe</i> | <i>kheu kheu kheu</i> (ㅋㅋㅋ) | ‘giggling’ |

The *bouba/kiki* phenomenon (also known as the *maluma/takete* phenomenon) is another example of a cross-linguistically wide-spread sound symbolism: speakers of many unrelated languages have been shown to share the intuition that certain sounds, such as *bouba*, correspond to large, round-shaped objects while other sounds, such as *kiki*, tend to correspond to smaller, sharper objects (e.g., Köhler 1929; Davis 1961; Holland & Wertheimer 1964; Nielsen & Rendall 2011; D’Onofrio 2014; for purported counterexamples, see e.g., Rogers & Ross 1975; Bremner et al. 2013). Children as young as 4 months have also been shown to be sensitive to *bouba/kiki* sound-shape associations (Ozturk et al. 2013; for studies with older children, see e.g., Maurer et al. 2006).

The presence of sound symbolism alongside arbitrariness in human language gives rise to questions about how language relates to the real world in the human cognitive system, which the bulk of sound symbolism research to date—including this paper—seeks to address. Which kinds linguistic forms are most likely to correspond to real-world meanings or functions? What are the language-specific versus cross-linguistic sources of these correspondences? And, looking from the other direction, which real-world referents beget sound symbolic correspondences? We overview the major elements behind these questions before turning to the current study’s contributions.

Cross-linguistically, certain linguistic properties tend to participate in consistent form-meaning correspondences. For example, reduplication commonly symbolizes repetitive action; vowel quality correlates with size (e.g., low, back vowels usually map to larger objects); vowel lengthening symbolizes duration or physical length; and obstruent voicing corresponds to weight or mass (e.g., voiced consonants usually map to heavier objects) (examples from Dingemanse et al. 2015). The *bouba/kiki* phenomenon in fact combines several of these form-meaning mappings; consonant voicing, vowel quality, and even consonant place of articulation (see D’Onofrio 2014). It remains unclear from the literature, however, whether all or only some linguistic properties participate in sound symbolism cross-linguistically, and why some appear to participate more than others.

One hypothesized source of sound-symbolic form-meaning mappings is perceptuomotor-based analogy, which maintains that sound symbolic linguistic features arise from acoustic or articulatory form that mimics properties of referents in a transparent, or iconic, way. Ohala (1994:330, 333) termed one version of this hypothesis the *frequency code* (frequency is only one dimension of the possible space of iconic sound symbolism). Under the frequency code, pitch corresponds to smaller referents and lower pitch corresponds to larger referents because pitch range correlates directly with anatomical morphology of the vocal tract when producing high versus low pitch. Similarly, under the frequency code, high vowels correspond to smaller referents and low vowels correspond to larger referents because of the oral aperture size differences in the production of high versus low vowels (see also Jespersen 1922; Sapir 1929). Insofar as anatomy is a source of iconicity, the frequency code predicts that sound symbolic form-meaning mappings should be largely cross-linguistically uniform, since they arise from common human vocal tract anatomy and mechanics.

It is not the case, however, that sound symbolism is cross-linguistically invariant. The *bouba/kiki* phenomenon has been reported to have some—albeit rare—exceptions: for instance,

Rogers and Ross (1975) report that speakers of the Songe dialect of Orokaiva (Austronesian; Papua New Guinea) are split in their sound symbolic associations of *maluma/takete*, with some demonstrating preference for the opposite sound symbolic correlation than expected. Differences between languages and sound symbolic mappings have also been demonstrated beyond *bouba/kiki*. Iwasaki et al. (2007:71–72), for example, found that while Japanese speakers were sensitive to both voiced and voiceless consonants in sound symbolic associations, English speakers were only sensitive to voiced consonants in sound symbolic associations.

Korean provides another example in which purportedly universal iconic form-meaning mappings run counter to expectations. Korean is reported to have sound symbolic correspondences between sets of vowels called “light” and “dark”, which correspond roughly but not exactly to low versus high vowels, respectively (see Cho & Iverson 1997 for discussion on how “dark” and “light” vowels do not form natural classes synchronically). “Light” vowels, including [o, a], reportedly indicate fast, brightly colored, nice, and smaller characteristics while “dark” vowels [u, ʌ] indicate slow, dark, and larger characteristics (Kim 1977): e.g., *khol khol* ‘child sleeping peacefully’ versus *khul khul* ‘snoring of adult’ (example from Garrigues 1995:368). Historically, “light” and “dark” corresponded to the concepts of *yin* and *yang*: *yang* being bright and male, with *yin* being the dark, female counterpart (Garrigues 1995:376; Cho 2006:66–67).

This sound symbolism in Korean has been of particular interest because it apparently flouts the expected direction of sound symbolic correspondences under the frequency code hypothesis, wherein high vowels align with smaller constructs (e.g., English diminutive suffix -y [-i]) and low vowels with larger constructs; see also Jakobson’s (1978:113) argument that acute vowels (i.e., front vowels), rather than grave vowels, evoke bright and thin images. It has been called into question to what extent Korean’s light and dark vowel division in sound symbolism is productive outside the mimetic lexicon. Shinohara and Kawahara (2010) give a counterexample to light and dark symbolism: in their nonword study, Korean speakers judged low vowels to be larger than high vowels, despite the reported lexical patterns for Korean. It seems, then, that there is room in sound symbolism for language-specific constraints (e.g., Korean’s “light” and “dark” patterns in the mimetic lexicon) alongside cross-linguistic perceptuomotor analogies.

Sound symbolism often occurs as iconic systematicities in a lexicon, where phonological patterns correspond to iconic functions. Phonaesthemes are one such example, in which phonotactic chunks correspond to a particular meaning that is often sound symbolic (Firth 1930; Bergen 2004). For example, the fricative+nasal cluster [sn-] occurs in English words that have to do with the nose: *snout*, *snot*, *snide*, *snore*, *sniff*, *sneeze*. Ideophones are another, word-level example of iconic systematicity: ideophones are words tied to some sensory imagery and which often serve adverbial or other specific grammatical functions in a language (e.g., Newman 2001; Dingemans 2012; Gasser et al. 2010). Japanese, as an example, has a large vocabulary of ideophones, often referred to as the mimetic stratum of the lexicon: *pikapika* ‘to sparkle’, *buyobuyo* ‘flabby, soft’ (mimetic words in Japanese are often characterized by reduplication; Hamano 1986).

Other lexical systematicities can be less overtly iconic but nonetheless hint at possible iconic connections. Personal names of different genders, for example, often exhibit phonotactic differences (Slater & Feinman 1985; Cassidy et al. 1999; Sidhu & Pexman 2015, 2019). In English, female names are more likely to end with vowels (e.g., *Amanda*, *Stephanie*) and male names are more likely to end with consonants (e.g., *Adam*, *Stephen*). Other male-female name differences in English include differences in name length, stress, and phonotactic patterns (for an overview, see e.g., Wright et al. 2005:539ff). In Chinese personal names, Starr et al. (2018) found that non-front vowels, unaspirated obstruents, and syllable-final velar nasals significantly correlate with male

names in both Mandarin (Mainland China and Taiwan) and Cantonese (Hong Kong) (e.g., in Mandarin, [kʊo³⁵ xɔŋ³⁵] 国宏 (m.) vs. [ɕin⁵⁵ tʃi³⁵] 心怡 (f.)). Further, in Mandarin, 4th tone (falling from high to low pitch) is also associated with male names, while phonological reduplication, which serves a diminutive function, is associated with female names (e.g., [liang⁵¹] 亮 (m.) vs. [ʃan⁵⁵ ʃan⁵⁵] 珊珊 (f.)). For name-based sound symbolic effects beyond gender, see Sidhu et al. 2016 on shapes and names; Barton & Halberstadt 2018 on face angularity and its congruity in naming; Shih & Rudin 2019 on names and baseball players' features; Sidhu & Pexman 2019 for a general overview.

Another possible source of sound-symbolic form and meaning correspondences, in addition to perceptuomotor analogy, is the learning of potentially arbitrary systematic patterns of association,¹ in which phonological regularities are manifested in parts of the lexicon (Monaghan et al. 2011; Monaghan et al. 2014). While the more iconic types of sound symbolism we have discussed so far are commonly found in mimetic vocabulary, other, arguably less iconic types of phonological subregularities are also commonly observed in non-mimetic lexical categories. For example, nouns and verbs in English demonstrate metrical differences, where disyllabic nouns tend to have initial stress and disyllabic verbs tend to have final stress (e.g., *récord* vs. *recórd*, respectively) (on noun vs. verb phonological differences, see e.g., Farmer et al. 2006; for phonotactic patterns of parts of speech generally, see e.g., Cassidy & Kelly 1991, 2001; Kelly 1992; Shih 2018). In Japanese, classes of words of different etymological sources exhibit phonotactic differences (e.g., Itô & Mester 1999): in native Yamato words, for instance, only one voiced obstruent is allowed within a morpheme.

While iconicity (i.e., sound meaning correspondences rooted in perceptuomotor analogy or acoustic mimicry) and systematicity (i.e., statistically non-chance correspondences between a sound pattern and a semantic, syntactic, lexical, or pragmatic category) are independent dimensions, sound symbolic systems inevitably involve the intersection—and most probably, the interaction—of both. For example, both iconicity and systematicity in sound symbolism have been shown to aid language acquisition and speech segmentation (see e.g., Imai et al. 2008; Kantartzis et al. 2011). Eckert (2017) points out also that phonological features that index sociocultural categories can often be iconic as well. And in some ways, iconicity can potentially feed systematicity: some real-world attributes are naturally easier to imitate than others, which may lead to greater systematicity and adoption throughout the lexicon (e.g., Eccarius & Brentari 2010; Coppola & Brentari 2014). It is not the case, however, that we find every possible real-world attribute—even ones that are easier to mimic in the linguistic domain (either spoken or signed)—is actually represented linguistically. Arbitrariness of the sign is, after all, still the null hypothesis that linguists bring to the study of lexical form. Systematic associations are inevitably balanced by arbitrary ones in order to allow for the necessary expressivity and flexibility in human language (for discussion, see e.g., Monaghan et al. 2014; Lupyan & Winter 2018). The question, then, is *which* real-

¹ There are other potential sources of sound symbolism that we will not address here: for instance, neuro-structural origins. Ramachandran and Hubbard (2001, 2005) point to synesthesia as a relative of sound symbolism, suggesting that synesthesia may be an exaggerated form of the cross-modal processing that is also at work in sound symbolic correspondences. To the extent that synesthesia may offer clues about the source of sound symbolism, it has been argued that there may be neurological bases to synesthetic connections: see Bargary & Mitchell 2008 for an overview. The psycholinguistic literature on synesthesia has also shown that frequency effects synesthetic associations (see Simner 2013: 154ff for an overview), suggesting that there may be learning-based sources to cross-modal associations as well.

world attributes result in sound symbolic representations, and whether these are common cross-linguistically or are culture-specific.

Thus on either side of the sound symbolic equation—meaning and linguistic form—there is still underdetermination in our understanding of how sound symbolism works, despite the growing literature. One particular challenge to studying cross-linguistic sound symbolic patterns is that, not only do linguistic systems shift across the diversity of human languages, but also the perception of real-world references shifts across the diversity of human cultures (for differences in cross-modal perceptual correlations, see esp. Bremner et al. 2013). Thus, finding a stable set of referents where only one side of the sound symbolic equation varies has been a problem.

One way that this issue has been addressed heretofore is through artificial lab setups (e.g., Imai et al. 2008; Kantartzis et al. 2011; D’Onofrio 2014). To the extent that these studies examine sound symbolism using real words, they often target "core vocabulary items" (e.g., Blasi et al. 2016; Wichmann et al. 2010). However, the size of such studies is often small. Blasi et al. (2016) and Wichmann et al. (2010), for example, used only 40 items out of the Swadesh list, which itself consists of only 200+ items. Johansson & Zlatev (2013) analyzed more than 100 languages, but they focused on only deictic expressions, of which there are only 28 pairs. In short, the numbers of items that are analyzed in studies of existing words are severely limited, maybe for a good reason—that is, the set of lexical items with identical functions across languages are inevitably quite small.

In this paper, we offer one of the first naturalistic observational studies of linguistic sound-meaning correspondences that utilises a controlled universe—the wildly popular *Pokémon* ecosystem—where non-linguistic variables (i.e., Pokémon attributes) are held constant, and only linguistic variables (i.e., Pokémon names) differ between languages. The Pokémon universe provides a much larger sample size—upwards of 800 words per language—to examine, without variation in their referents. We examine six languages: Japanese (JPN), English (ENG), Mandarin (CMN), Cantonese (YUE), Korean (KOR), and Russian (RUS).² Our results show both that cross-linguistic symbolisms are common across all of the languages studied, and that specific differences in symbolism arise from language-specific structural and lexical constraints. We also take up the issue of *which* real-world referents trigger sound symbolic correspondences. Our results suggest that the real-world referents that beget sound symbolic correspondences are the ones most salient to survival fit in the (Pokémon) universe.

The paper is organized as follows. Section 2 introduces the Pokémon dataset and reviews previous work on Pokémon name and sound symbolism. Section 3 introduces the data and methodology used in the study, and §4 presents the results for each language. Section 5 discusses cross-linguistic similarities and differences in Pokémon sound symbolism across the languages studied, and §6 discusses the ramifications for understanding the connections between real-world attributes and phonological representations of them. Section 7 concludes.

2 Pokémon and their names

Data for this study of sound symbolism comes from the *Pokémon (Pocket Monsters)* videogames, which were first developed in 1996 and continue to be played and further augmented. Published by Nintendo, the videogame franchise is popular worldwide, and has expanded into several other mediums, including trading cards, television shows, movies, mobile gaming apps, and a musical.

² Where possible, we use ISO-639-3 language codes as shorthand in examples.

Pokémon was originally released in Japan. The latest version of the game as of the writing of this article (*Sun and Moon*, Generation VII, 2016³) was officially released in Japanese, English, Korean, traditional and simplified Chinese, French, German, Italian, and Spanish. Information for the Pokémon names analyzed in our study were taken from the *Sun* and *Moon* versions of the game (released between 2016–2017), as codified in *Bulbapedia*, a fan-based web encyclopedia of Pokémon data. The entire index of Pokémon names and Pokémon attributes is known in game as the *Pokédex*.

There are 802 Pokémon characters, each with a different name (a few repeat, because they have differing physical attributes; the corpus total with repeats is $n=814$). We provide the Pokédex numbers with each character here for reference, as well as language codes when needed, to indicate the name’s language: for example, *Blastoise*, ENG, #009.

2.1 Pokémon attributes

Pokémon involves animal-like characters: the goal of the game is to collect the complete *Pokédex* by collecting at least one character of each Pokémon species (each in-game instance of a character belongs to a given Pokémon species). Players train their Pokémon characters to battle. Winning battles increases the power statistics of the Pokémon, helps them grow, and leads to the potential capture of new Pokémon for the player’s Pokédex collection.

Each Pokémon has several game-defined attributes, many of which are numerical in nature. In this study, we examine the following: weight, height (i.e., size),⁴ total performance statistic (i.e., total power), evolutionary stage, and gender. Examples of Pokémon with some of the most extreme measures in these attributes are given in Table 1, ordered here by increasing power.

Pokedex	Name (ENG)	Height (m)	Weight (kg)	Total Power	Evolutionary stage	Male/Female (%)
#746	Wishiwashi	0.2	0.3	175	2	50/50
#191	Sunkern	0.3	1.8	180	1	50/50
#789	Cosmog	0.2	0.1	200	1	None
#669	Flabébé	0.1	0.1	303	1	0/100
#742	Cutiefly	0.1	0.2	304	1	50/50
#790	Cosmoem	0.1	999.9	400	2	None
#321	Wailord	14.5	398	500	2	50/50
#791	Solgaleo	3.4	230	680	3	None
#493	Arceus	3.2	320	720	Legendary	None

Table 1. Examples of Pokémon and their attributes.

Each Pokémon has weight (in kilograms) and height (in meters) measurements. Total power is a catch-all statistic that includes health points, attack, defense, special attack, special defense, and speed. Most Pokémon can undergo evolution to become larger and more powerful, from Stage 1 to Stage 3: for example, *Abra* (ENG; Stage 1; #063) evolves to *Kadabra* (Stage 2, #064) evolves to *Alakazam* (Stage 3, #065). Some Pokémon do not evolve to or from any other stages; these were

³ *Ultra Sun* and *Ultra Moon* were released later: they are still considered Generation VII, but with extra content.

⁴ For more serpentine Pokémon (e.g., *Ekans*, ENG, #023; *Dragonair*, ENG, #148), height refers to length.

coded as Stage 2 because they typically resemble Stage 2 characters in terms of attributes. There are also baby versions of certain Pokémon (coded here as Stage 0; e.g., *Pichu*, ENG/JPN, #172, is the baby stage of *Pikachu*, #025) and legendary Pokémon (Stage ‘L’; e.g., *Raikou*, #243), which do not typically evolve to or from any other Pokémon. The most recent generation of the game (Generation VII) introduced 11 new Legendary Pokémon, of which some evolve (e.g., *Type:Null*, ENG/JPN, #772, evolves to *Silvally*, ENG,⁵ #773). Finally, each Pokémon is also assigned a likelihood with which it appears in the game as male or female. Some species are invariably either male (e.g., *Braviary*, ENG, #628) or female (e.g., *Blissey*, ENG, #242). For other species, individual Pokémon are either male or female, in some species-level proportion (e.g., *Bunnelby* appears 50% male/50% female, ENG, #659), or are gender neutral (e.g., *Staryu*, ENG, #120).

2.2 Pokémon names

We call the names of the Pokémon characters here *pokemonikers*. Our study includes *pokemonikers* for each of the characters in Japanese, English, Mandarin, Cantonese, Korean, and Russian.

Phonological transcription for Japanese names were taken from the orthography, which reflects pronunciation. English *pokemonikers* were pronounced and recorded by the 3rd author, who is a Pokémon “native speaker” with extensive experience in the Pokémon game ecosystem as a seasoned game player. The English pronunciations were transcribed by an undergraduate research assistant (Alison Orgun) and the 4th author.

Russian *pokemonikers* were pronounced and recorded by two 10-year old children in Moscow. One child is a monolingual speaker of Russian; the other is an L1 speaker of Russian and an L2 speaker of English and Japanese. The Russian pronunciations were transcribed by two Russian-fluent graduate research assistants (Maria Whittle, David Parker) and checked by the 7th author, who is a native Russian speaker.

The Chinese Mandarin and Cantonese *pokemonikers* were transcribed by an undergraduate research assistant (Max Fennell-Chametzky) based on their standard romanizations and taking into account tone sandhi in the two languages. The Mandarin data was checked by a graduate RA (Tianxiao Wang, a Mandarin native speaker) and the 10th author (a Cantonese and Mandarin speaker); the Cantonese data was checked by the 10th and 11th authors (the latter a Cantonese native speaker).

The Korean *pokemonikers* were transcribed by the 5th, 6th, and 9th authors (two native Korean speakers, and one L2 Korean speaker), based on the contemporary Seoul dialect.

2.2.1 On the development of Pokémon names

According to a game development source (Yin-Poole 2011), Japanese Pokémon names are historically developed before names in other languages, often based on word meanings. For example, *Hitokage* (JPN, #004) is the Japanese name for the lizard-shaped Pokémon with a flaming tail: its name in Japanese blends *hi* ‘fire’ and *tokage* ‘lizard’. Because descriptive meanings of the name take precedence in the naming of characters, the *pokemonikers* are not explicitly based on sound symbolisms. However, some names do involve sound symbolism in Japanese, mainly because

⁵ *Shiruvadi* in Japanese.

their blends involve existing ideophones. For example, *Pikachu* (#025) is a combination of the Japanese ideophones *pikapika* ‘to sparkle’ and *chuuchuu* ‘squeaking’.

Pokémon names in other languages are developed in one of two ways. In the official established markets, including the English, Chinese, and Korean speaking markets, Pokémon names are developed locally (i.e., ‘localized’) for those languages, based on meaning preservation of certain Pokémon characteristics.^{6,7} For example, *Hitokage* (JPN) in English is *Charmander*, a blend of *char* and *salamander*. The Mandarin Chinese name for *Hitokage* is 小火龍 [eiau³⁵ xuo²¹⁴ loŋ³⁵],⁸ from 小 ‘small’, 火 ‘fire’, and 龍 ‘dragon’. The Korean name for the same character is 파이어리 [p^hairi], a blend of the Korean pronunciation of English *fire*, 파이어 [p^haiɾ], and 꼬리 [k^ori], meaning ‘tail’.

Some Japanese names do phonologically overlap with English, Chinese, and Korean names. Between English and Japanese, about 25% (190/814) of the pokemonikers are phonologically similar. Between Mandarin Chinese and Japanese, about 14% (113/814) are phonologically similar. Between Korean and Japanese, about 34% (278/814) are phonologically similar. *Pikachu*, for example, is the same in all four languages: *Pikachu* in English, Korean, and Japanese,⁹ and 皮卡丘 [p^hi³⁵ ka²¹⁴ tɛ^həu⁵⁵] in Mandarin. It is important to note, however, that these shared pokemonikers are not always Japanese in origin. Some Japanese names are themselves based on English words. For example, *Cosmog* (ENG, #789) is an English blend of *cosmos* and *smog*. The Japanese name, *Kosumoggu*, is a transliteration from English, as are the Mandarin and Korean names, 科斯莫古 [k^hɿ⁵⁵ si⁵⁵ mwo⁴¹ ku²¹⁴] and 코스모그 [k^hosimogɿ], respectively. Japanese names that are based on Chinese are much rarer. One possible example is *Houou* (#250; *Ho-Oh*, ENG), which comes from the Japanese *on’yomi* reading of the Chinese word for ‘phoenix’: 鳳凰 [fəŋ⁵¹ xuan³⁵].¹⁰

In other markets, including Russian, names are simply transliterations from either the existing Japanese or English Pokémon names, with no localization of semantic content. *Charmander* (#004), for example, is *Чармандер* [tʃer'mander] in Russian.

⁶ Pokémon names have also been localized for French and German markets.

⁷ The Cantonese names present an interesting twist. In the past, Pokémon was released in Hong Kong using pokemonikers developed for Cantonese. In 2016, however, Nintendo decided to unify the Chinese markets, and united all Chinese markets under Mandarin-based pokemonikers. A total of 205 Pokémon names were thus changed from the original Cantonese set in the release of Generation VII. As a result, some of the Cantonese names moved further from phonological faithfulness to Japanese, because they were now based on readings of the characters for Mandarin transliterations. For example, *Pikachu* (#025) was originally 比卡超 [pei²⁵ k^ha⁵⁵ ts^hi:w⁵⁵] in Cantonese. After the 2016 change, the Mandarin name is used. In Mandarin, the name is 皮卡丘 [p^hi³⁵ k^ha²¹ tɛ^hiou⁵⁵], which is phonologically quite faithful to the Japanese name; however, in Cantonese, the reading of the same characters [p^hei²¹ k^ha⁵⁵ jɛu⁵⁵], is no longer faithful to the onset or nucleus of the final syllable. Here, we present results using the original set of Cantonese names.

⁸ Mandarin and Cantonese lexical tones are indicated using “Chao digits”, meaning pitch values from 1 (low) to 5 (high), as first proposed by Chao (1930; see also Duanmu 2002: 210). The tones indicated in this paper do not reflect the citation tone of the syllable in isolation, but rather the tone contour of the syllable when occurring in a given context, incorporating tone sandhi effects.

⁹ There is a minor length distinction in English *Pikachu* versus Japanese *Pikachuu*.

¹⁰ The second *ou* of the Japanese pokemoniker *Houou* can also be a reference to 王 ‘king’: in fact, the Mandarin pokemoniker of this character is 鳳王 [fəŋ⁴ waŋ²] ‘phoenix king’. Since all Pokémon names are written with the katakana orthography, there is no way to tell for certain which morpheme (or Chinese character) is intended. It is also likely that names have double meanings.

2.3 Previous work on pokemonikers

Kawahara et al. (2018) were the first to note correlations between Pokémon names and the physical attributes of the characters.¹¹ They examined the number of moras and voiced obstruents in Japanese pokemonikers. They found that number of moras in a pokemoniker significantly and positively correlated with the weight, height, power, and evolutionary stage of a Pokémon. For example, in Japanese, *Isitsubute* (ENG: *Geodude*, #074) has five moras and *Pikachuu* (#025) has four: the former is 14 kilograms heavier than the latter, all else being equal (the two characters are the same size, power, and evolutionary stage). Similarly, more voiced obstruents in a pokemoniker positively correlated with size, power, and evolutionary stage. Kawahara et al. (2018) also looked briefly at the vowel quality of initial vowels and segment length; however, mora count and voiced obstruents were the most significant correlates of Pokémon physical attributes.

In a follow-up experimental paradigm, Kawahara and Kumagai (2019) found that the sound symbolic correlations between moras, voiced obstruents, and Pokémon evolutionary stage hold for both Japanese and English speakers when encountering novel Pokémon characters. They presented a pair of new Pokemon pictures drawn by a digital artist, one corresponding to a pre-evolution stage and the other corresponding to a post-evolution stage. They also presented a pair of two nonce names (e.g. *domana* vs. *hifuro*) and asked which name better corresponds to which character. Both Japanese and English speakers were more likely to associate names with a voiced obstruent (i.e. *domana*) with post-evolution characters.

3 Data & Methodology

The current study builds on previous work in two ways: with a greater number of potential phonological correlates to Pokémon attributes in more languages: Japanese (§4.1), English (§4.2), Mandarin (§4.3), Cantonese (§4.4), Korean (§4.5), and Russian (§4.6). In each language, we examine how often given prosodic, vowel quality, consonant quality, and morphophonological features occur in the pokemonikers. Linguistic features were chosen based on reported sound symbolic behaviours in the existing literature; furthermore, we sought to look at the same (or similar) linguistic features across the languages in this study, for the purposes of cross-linguistic comparison. We acknowledge that constellations of segmental and suprasegmental features often work together for sound symbolism (see discussion in e.g., Dingemanse et al. 2016: e128ff); however, to investigate all combinatoric patterns would be beyond the scope of a single paper. We thus start here with individual feature-attribute correlations and save the role of combinatoric patterns (e.g., phonotactic sequences) in Pokémon sound symbolism for future work.

For Pokémon attributes, we tested height, weight, total power statistic, evolutionary stage, and gender ratio (i.e., species-level percentage of occurring as male). Weight was log-transformed due to the heavy right-skewing of the data. Although previous work has shown some independence between the various types of individual performance statistics (particularly in the statistic for speed; e.g., Kawahara et al. 2018), we use the total power statistic here to corral the scope of the current analysis. Evolutionary stages were coded as Stages 1–3 for regular evolutionary stages (Stage 1 $n=249$, Stage 2 $n=370$, Stage 3 $n=103$); 0 for baby Pokémon ($n=19$); and L for legendary Pokémon ($n=73$). Legendary Pokémon were excluded from analyses of stage and sound

¹¹ For previous work on Japanese pokemonikers, see Ohyama 2016 on the morphophonology of blending in Pokémon name formation, and Miura et al. 2012 on machine learning of Pokémon names and strength correlations.

symbolism. Gender was measured as the percent with which a Pokémon occurs as male. Genderless Pokémon characters were excluded from the gender analysis ($n=106$).

Correlations between linguistic features and Pokémon attributes were tested using an ensemble method encompassing three statistical approaches: basic correlation tests, classification tree models, and regression models. Rank correlation tests (Spearman, Kendall) between one linguistic feature and one Pokémon attribute were used: a high bar for significance in correlation was utilized, because basic rank correlation tests do not control for other potentially influential variables. Significance was held at $p < 0.01$. Classification tree models were run, predicting each Pokémon attribute on all linguistic features in a given language that were identified as significant in the rank correlation tests. Regression models (linear or ordinal, where appropriate) were also run, predicting each Pokémon attribute as a function of all linguistic features in a given language that were identified as significant in the rank correlation tests. In the regression models, all variables were centered and standardized (following Gelman 2008).

Results were obtained using an ensemble voting, majority-wins algorithm, to ensure that the phonological features that most robustly associate with Pokémon attributes across all tests are the ones that are reported. The significant results reported here are ones that were significant across the statistical methods as outlined in the paragraph above; trending results are ones that were significant in only two out of three methodologies. Given their robustness, these sound symbolisms should be the ones most likely to be obvious to learners. It is possible that other cues matter (e.g., phonotactic patterns), or that they work in concert with the ones identified here (e.g., interactions). These possibilities are reserved for future investigation.

4 Results

Results for each language in the study are summarized in Table 2. Specific statistical results (e.g., regression coefficients, significance values) are provided in Appendices A–C. We summarize and discuss the results for each language on its own below. Comparisons across languages are discussed in §§5 and 6.

		<i>Linguistic features</i>					
		Japanese	English	Mandarin	Cantonese	Korean	Russian
<i>Pokémon attributes</i>	Weight	↑ mora ↑ +voi obstr (↓ labial C) (↓ palatal C)	↑ sonorant C (↑ +voi obstr) (↓ labial C) (↑ low V)	↑ syllable ↓ redup	↑ syllable ↓ redup (↓ non-high V)	↑ central V (↑ segment) (↑ alveolar C) (↑ velar C)	↑ alveolar C ↑ velar C (↑ sonorant C)
	Height	↑ mora ↓ labial C	↓ labial C (↑ low V)	↓ redup	↓ redup (↓ tone 2)	↑ central V (↓ tense C) (↑ non-high V)	
	Power	↑ mora ↓ labial C	↑ segment ↓ labial C (↑ low V)	↑ syllable ↓ redup ↑ front V (↑ tone 4)	↓ redup ↓ tone 2	↑ central V ↑ segment ↓ tense C	
	Stage	↑ mora (↑ +voi obstr) (↓ labial C)	↑ segment	↑ syllable ↓ redup (↑ tone 4)	↑ syllable ↓ redup ↓ tone 2	↑ segment (↓ tense C)	↑ segment (↑ sonorant C)
	Gender (Male %)	↓ sonorant C	↑ back V	(↓ redup) (↑ low tones: 3, 4)	(↓ redup) (↑ tone 6)		(↑ mid V)

Table 2. Summary of significant correlations between Pokémon attributes and linguistic features. Arrows indicate direction of correlation: ↑ = positive, ↓ = negative. Correlations in parentheses indicate trending effects that approach significance.

4.1 Japanese

All linguistic features that were examined for Japanese in the current study are given in (2). Significant correlates of Pokémon features are marked with a *; trending correlates are marked with a †.

- (2) **Prosodic factors** moras in word*
Vowel quality [+HIGH], [−HIGH], [+FRONT], [−FRONT]
Consonant quality [+VOICE] obstruents*, [−VOICE] obstruents, [SONORANT] consonants*, [LABIAL]*, [PALATAL]†, [VELAR]

4.1.1 Prosodic factors

As observed in previous work (Kawahara et al. 2018; Kawahara & Kumagai 2019), pokemoniker length is a strong correlate of several Pokémon attributes: the longer the name, the heavier, taller, stronger, and more evolved a character tends to be. We replicated Kawahara et al. 2018’s result

here.¹² Longer names (i.e., more moras and syllables) positively and significantly correlate with heavier, more sizable, more powerful, and more evolved Pokémon. Figures 1a–c show the correlations between the number of moras and Pokémon weight, size (height), and power. Figure 1d shows the correlation between Pokémon evolutionary stage and the mean number of moras.

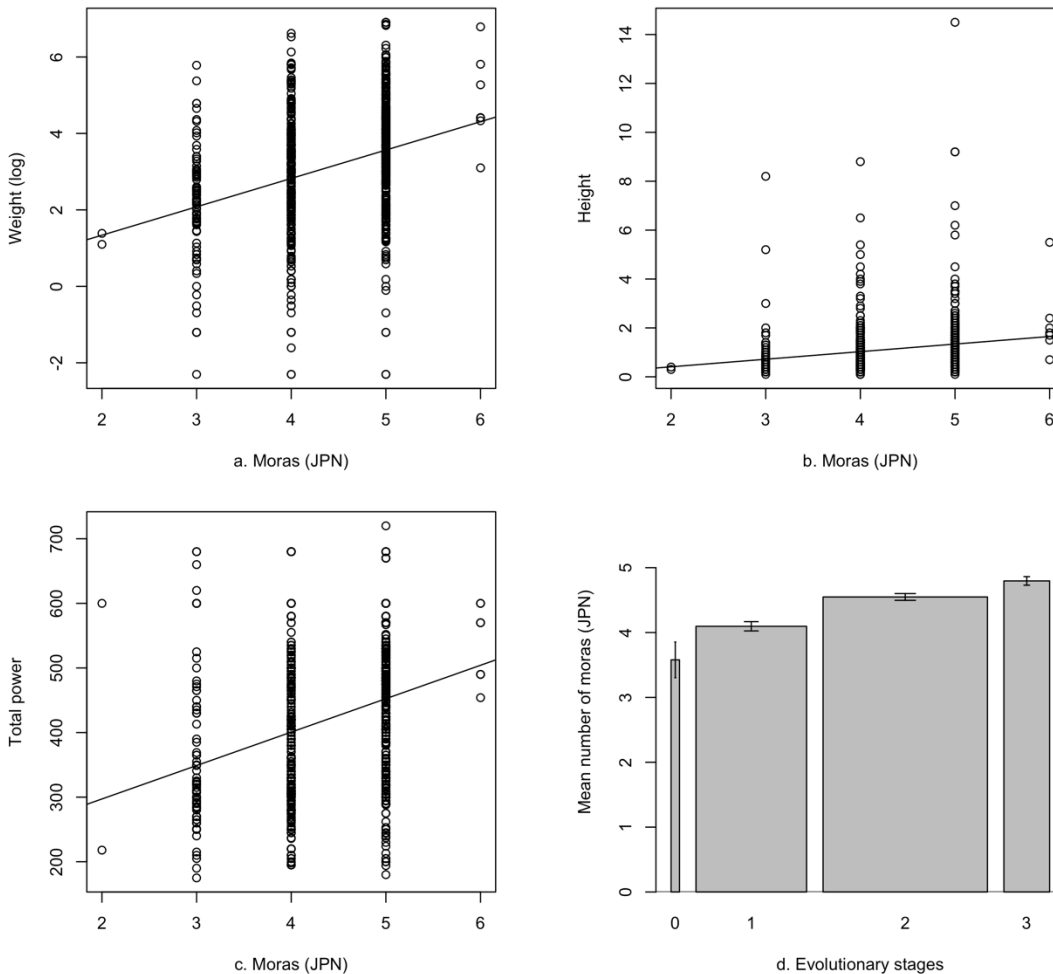


Figure 1. Correlations between number of moras (JPN) and Pokémon attributes (left to right): (a) weight, (b) height (size), (c) power, and (d) evolutionary stage (width of bars are scaled by proportion of data).

No significant correlations between prosodic factors and Pokémon gender were found by the ensemble method used here.

¹² Kawahara et al. (2018) studied pokemonikers up to and including Generation VI, and the current study expands on the size of the dataset. The current study also examines phonological dimensions which were not analyzed by Kawahara et al (2018). Finally, Kawahara et al. (2018) did not study Pokémon gender.

4.1.2 Consonant quality

Like Kawahara et al. 2018, we find a significant and positive correlation between the number of voiced obstruents in a pokemoniker and Pokémon weight, as illustrated in Figure 2a. This effect remains significant when controlling for name length via multivariate regression.

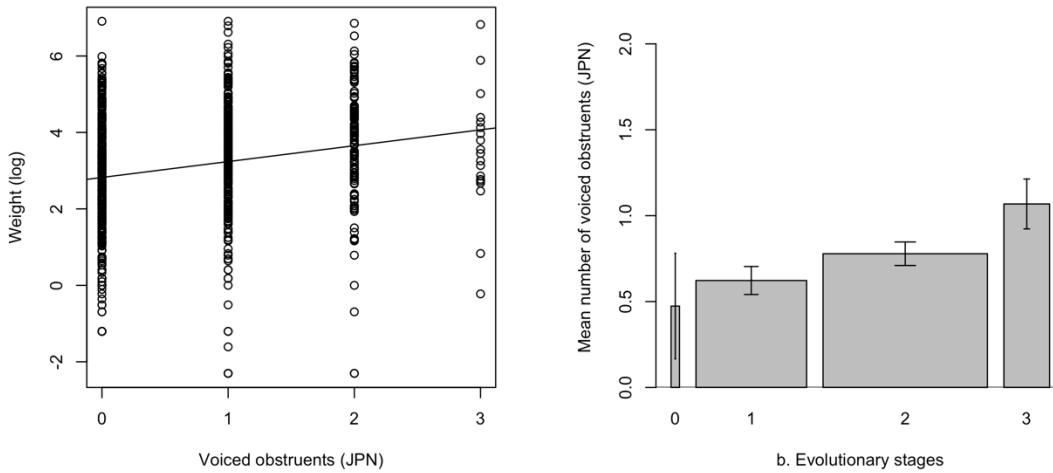


Figure 2. Correlations between number of voiced obstruents (JPN) and Pokémon attributes (left to right): (a) weight, (b) evolutionary stage (width of bars are scaled by proportion of data).

There is also a trending effect of voiced obstruents positively correlating with Pokémon evolutionary stage, as shown in Figure 2b. The correlations of voiced obstruents with increases in Pokémon weight and evolution follow expected patterns of sound symbolism, where voicing—versus voicelessness—tends to pattern with larger structures (Hamano 1986; Shinohara & Kawahara 2010).

We also find significant correlations between labial consonants and several Pokémon attributes. The presence of labial consonants negatively correlates with weight, size, power, and evolutionary stage: that is, Pokémon with more labial consonants will generally be smaller and less powerful, as shown in Figure 3.

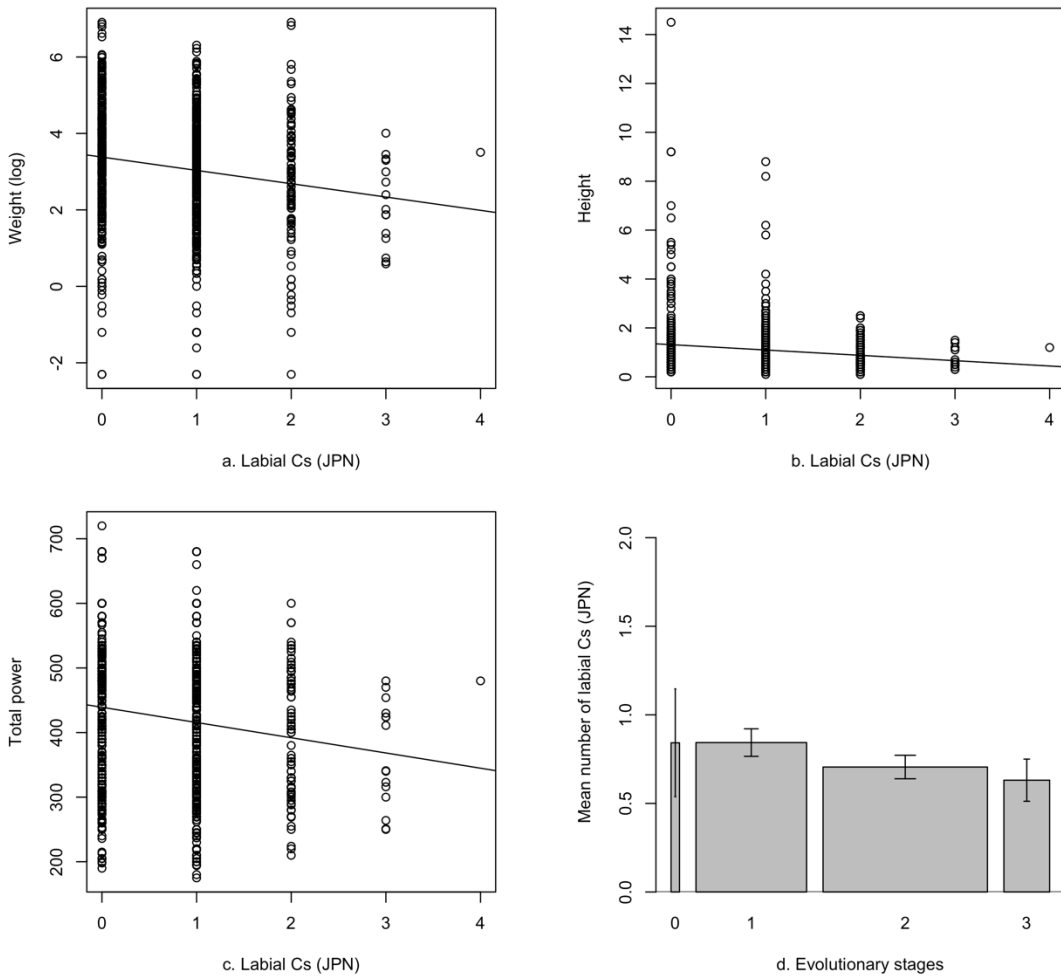


Figure 3. Correlations between number of labial consonants (JPN) and Pokémon attributes (left to right): (a) weight, (b) height (size), (c) power, and (d) evolutionary stage (width of bars are scaled by proportion of data).

The connection between labial consonants and smaller Pokémon characters is reminiscent of the propensity in Japanese to associate labial sounds with babies. For example, Kumagai and Kawahara (2017) report on the prevalence of labial consonants in diaper brand names in Japan: e.g., *mamiipoko*, *muunii*, *merriizu*, *pampaasu*.¹³ They also found this sound symbolic association pattern to be productive when Japanese speakers were asked to come up with new diaper names. We discuss in §5 to what extent this labial consonant-to-smaller Pokémon symbolism is cross-linguistic versus language-specific.

There is a trending effect of palatal consonants being negatively correlated with Pokémon weight: more palatal consonants in a name correspond to lighter Pokémon. This pattern concords with previously observed correlations in Japanese between palatalization and childishness (e.g., Hamano 1986: 238ff): e.g., [ɲ]oko-[ɲ]oko ‘moving like a small child’ versus [t]oko-[t]oko ‘trotting’ (example from Alderete & Kochetov 2016:731). In addition to childishness, palatalization has also been observed in Japanese to correlate with meanings of “unreliability, uncoordinated movement, diversity, excessive energy, noisiness, lack of elegance, and cheapness”: e.g., ka[ɲ]a-ka[ɲ]a ‘keys

¹³ The last one in this list is a borrowing from English *Pampers*.

hit each other and make a variety of noises’ versus *ka[t]a-ka[t]a* ‘something solid and square hits a hard surface and makes a homogeneous sound’ (Hamano 1986: 238–239). We find, however, no other significant semantic correlates of palatalization in the Japanese pokemonikers.

Finally, the only significant correlate to Pokémon gender that we find is sonorant consonants, shown in Figure 4.

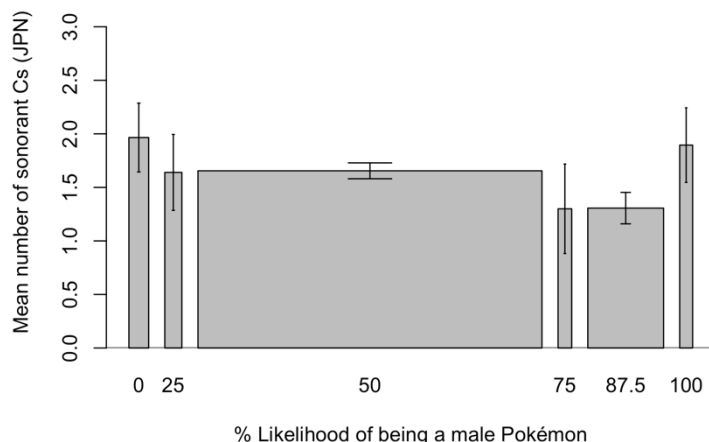


Figure 4. Correlation between number of sonorant consonants (JPN) and Pokémon gender likelihood of being a male Pokémon (width of bars are scaled by proportion of data).

Overall, pokemonikers with more sonorant consonants are more likely to be female-dominant characters. We find that this pattern follows the distribution of sonorant consonants in Japanese names (for humans). Shinohara and Kawahara (2013) analyzed the 50 most popular Japanese male and female names from the 2011 Meiji Yasuda Seimei list and found that female names are more likely to contain sonorants than obstruents (72 v. 35, respectively), whereas male names are more likely to contain obstruents than sonorants (67 v. 37, respectively) ($\chi^2=20$; $p<0.001$).

4.1.3 Vowel quality

We did not find any significant correlates across our ensemble model for vowel quality properties and Pokémon attributes. While there were some significant *rho* correlations in the descriptive statistics (e.g., more back vowels correspond to larger and stronger Pokémon; see Appendix A), these effects did not remain significant when other variables were controlled. Kawahara et al. (2018) likewise found small correlations between vowel height and Pokémon size and weight.

4.2 English

Linguistic features that were examined in English are given in (3).

- (3) **Prosodic factors** syllables*, segments*
Vowel quality [+HIGH], [−HIGH, −LOW], [+LOW][†], [+FRONT], [−FRONT]*
Consonant quality [+VOICE] obstruents[†], [−VOICE] obstruents, [SONORANT] consonants*, [LABIAL]*, [ALVEOLAR], [VELAR]

4.2.1 Prosodic factors

Two measures of word length were tested for English: the number of syllables and the number of segments. As with Japanese, there are significant positive correlations in English between longer words and more powerful, evolved Pokémon, shown in Figure 5.

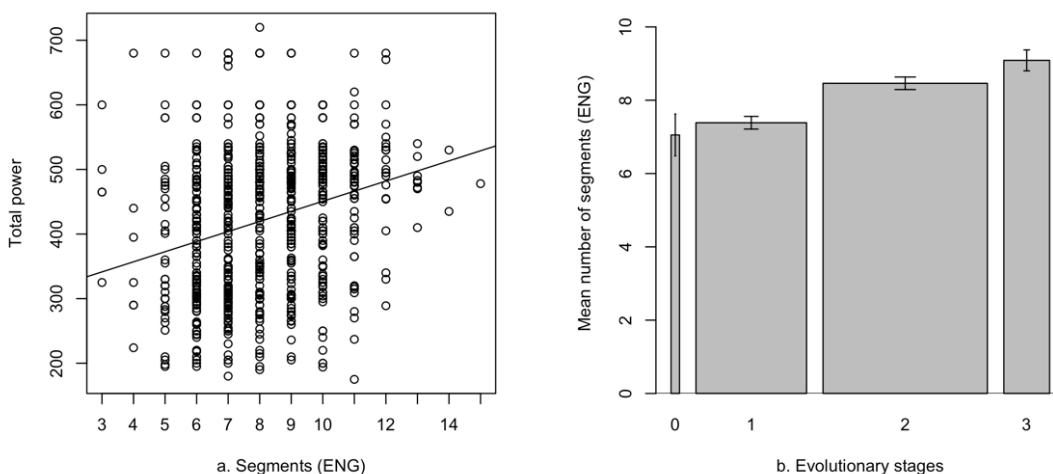


Figure 5. Correlation between number of segments (ENG) and Pokémon attributes (left to right): (a) power, and (b) evolutionary stage (width of bars are scaled by proportion of data).

Both measures of word length—syllables and segments—were significant. Because it is possible to add segments to words in English without increasing the number of syllables, segments were a more fine-grained unit with which to measure length. As such, we report on segment-based results here. Unlike in Japanese, we did not find significant correlations in our ensemble model for word length and Pokémon size and weight, once other factors were controlled.

4.2.2 Consonant quality

Three consonant quality features correlated significantly with Pokémon attributes. Names with more sonorant consonants tend to belong to heavier Pokémon, as illustrated in Figure 6.

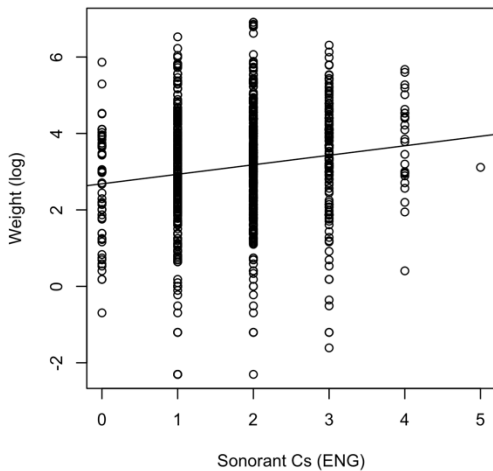


Figure 6. Correlation between number of sonorant consonants (ENG) and Pokémon weight.

Sonorants have been sound-symbolically linked to rounder and more “mellifluous” shapes and sounds in the literature: see for example, experimental evidence from Nielsen & Rendall 2011, 2012.

As in Japanese, we find negative correlations between the number of labial consonants and Pokémon weight, size, and power:

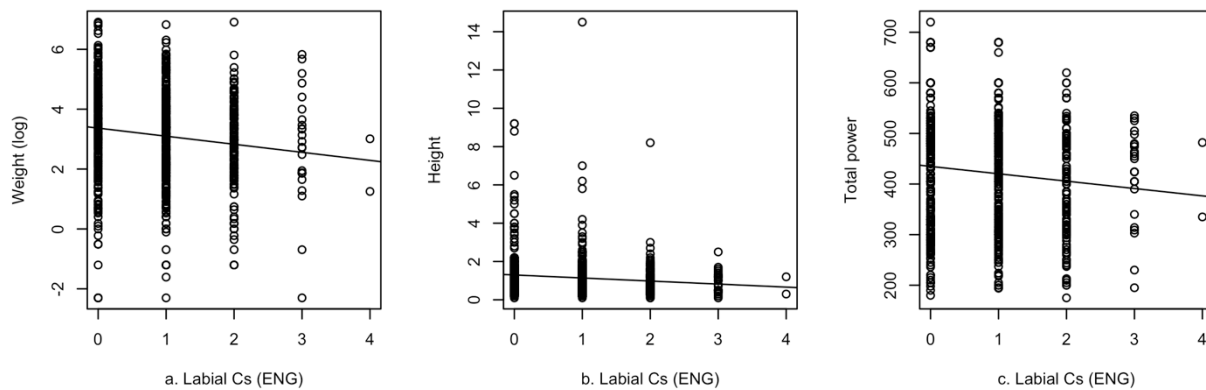


Figure 7. Correlations between number of labial consonants (ENG) and Pokémon attributes (left to right): (a) weight, (b) height (size), and (c) power.

We also find a trending effect of the number of voiced obstruents in a word positively correlating with heavier Pokémon, shown in Figure 8. This effect follows Newman’s (1933:63) experimental finding that, for English speakers, voiced obstruents are associated with largeness, whereas voiceless obstruents are more often associated with smallness. This result also parallels the same effect found in Japanese (§4.1.2).

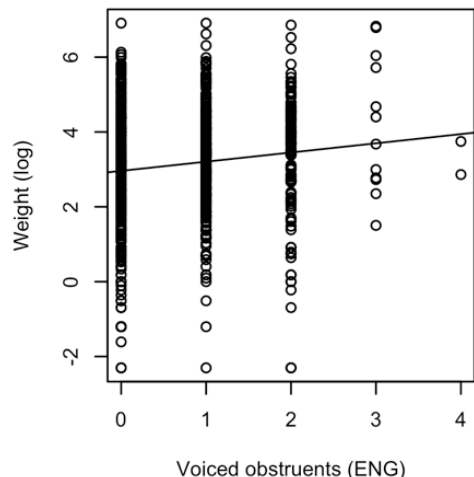


Figure 8. Correlation between number of voiced obstruents (ENG) and Pokémon weight.

4.2.3 Vowel quality

There is a positive correlation with the number of low and/or back vowels in a pokemoniker and its size, weight, power, and gender. In English, low and back vowels have been reported to correlate with larger and darker (vs. smaller and brighter) semantic associations (see e.g., Newman 1933:63): such effects have also been found in English brand names (e.g., Jurafsky 2013)

Having more low vowels [æ, ɑ, ɔ, ɑ̃, ɑ̃] in a pokemoniker is associated with increases in weight, height, and power, as shown in Figure 9.

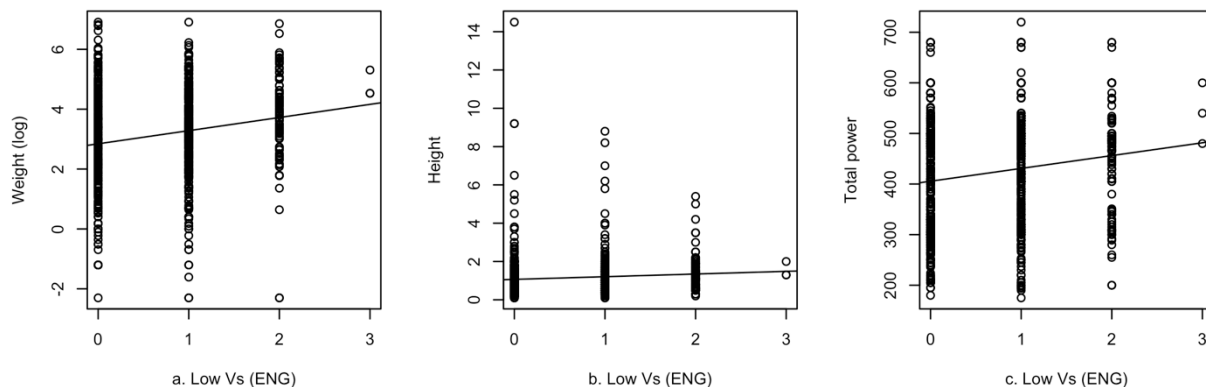


Figure 9. Correlations between number of low vowels (ENG) and Pokémon attributes (left to right): (a) weight, (b) height (size), and (c) power.

Having more back vowels [ɑ, ɔ, o, u, ʊ, ɑ̃, ɑ̃, ɔ̃] in a pokemoniker is significantly correlated with a greater likelihood in presenting as a male character. This pattern aligns with patterns from names in English more generally. Comparing the 100 most frequent male versus female names in

English (between 1918–2017),¹⁴ there are significantly more back vowels in male names than in female names ($\chi^2=10.279$, $p=0.001$).

4.3 Mandarin

Linguistic features that were examined in Mandarin are summarized in (4).

- (4) **Prosodic factors** syllables*, reduplication*, tone*
Vowel quality [+HIGH], [−HIGH], [+FRONT]*, [−FRONT], diphthongs
Consonant quality [+SPREAD GLOTTIS] obstruents, [−SPREAD GLOTTIS] obstruents,¹⁵ [SONORANT] consonants, [LABIAL], [PALATAL], [RETROFLEX], [VELLAR, NASAL]

4.3.1 Prosodic factors

As with Japanese and English pokemonikers, there is a significant positive correlation between the length of a Mandarin Chinese Pokémon name (e.g., as measured by syllables) and its weight, power, and evolutionary stage, as shown in Figure 10.

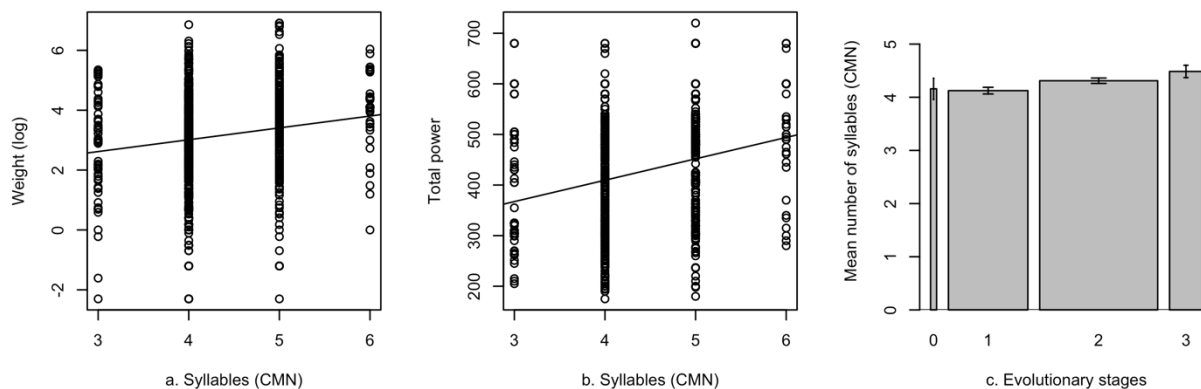


Figure 10. Correlations between number of syllables (CMN) and Pokémon attributes (left to right): (a) weight, (b) power, and (c) evolutionary stage (width of bars are scaled by proportion of data).

In Chinese (both Mandarin and Cantonese), reduplication is a common sound symbolic phonological feature (Li & Thompson 1989; Mok 2001). Among other features, reduplication often is used for the diminutive in Chinese: for instance, 狗狗 ‘doggie’ is derived from reduplicating the word 狗 ‘dog’. Reduplication with this diminutive function is often found in names for both pets and people (and particularly for women), as in the name of Chinese actress 范冰冰 ‘Fan Bingbing’ (Starr et al. 2018). The diminutive function of reduplication in Chinese is a feature of nouns; elsewhere in Chinese grammar, reduplication has other functions.

¹⁴ Data from the U.S. Social Security Administration website: <https://www.ssa.gov/oact/babynames/decades/century.html>

¹⁵ In terms of voice onset time, [p, t, k] in Mandarin are comparable to [b, d, g] in English, despite their differing IPA transcriptions (see e.g., Chang et al. 2011); in the literature, the distinction is traditionally described as [±SPREAD GLOTTIS] for Chinese.

For this study, reduplication was coded as any full or partial repetition within a name: for example, 波波 [po⁵⁵ po⁵⁵] (full reduplication; #016) and 比比鳥 [pi³⁵ pi³⁵ niau²¹⁴] (partial reduplication; #017). In the pokemonikers, we found that reduplication significantly correlates with many of the Pokémon features investigated: in fact, it was the most robust and prominent sound symbolic correlate in the Chinese languages that we investigated—see Figure 11.

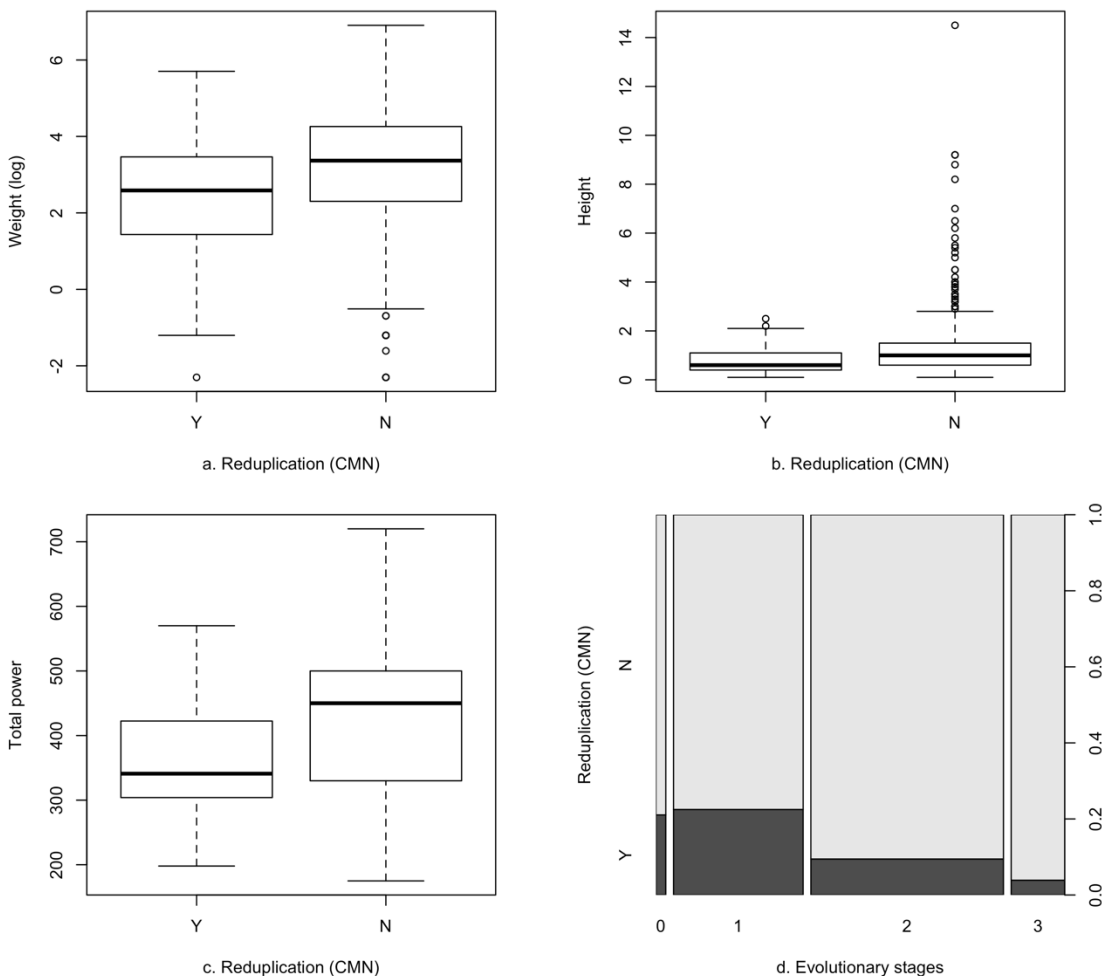


Figure 11. Correlations between presence of reduplication (Yes vs. No, CMN) and Pokémon attributes (left to right): (a) weight, (b) height, (c) power, and (d) evolutionary stage (width of bars are scaled by proportion of data).

The presence of reduplication patterns with lighter, smaller, less powerful, and less evolved characters. For example, both baby stage 皮寶寶 [p^hi³⁵ pau³⁵ pau²¹⁴] (*Cleffa*; #173) and Stage 1 皮皮 [p^hi³⁵ p^hi³⁵] (*Clefairy*; #035) feature reduplication. The subsequent evolution to the final form Stage 2 皮可西 [p^hi³⁵ k^hɿ²¹ ɕi⁵⁵] (*Clefable*; #036) removes reduplication. The presence of reduplication also trends with the greater likelihood of occurring as a female Pokémon.¹⁶ It appears, then, for Pokémon in Chinese, reduplication is associated most strongly with diminution.

¹⁶ There may also be effects of orthographic reduplication in Chinese, where radicals within each character are repeated (but do not reflect any phonological repetition in pronunciation): for example, the 虫 ‘insect’ radical in 蜈蚣王 [u³⁵ koŋ⁵⁵ waŋ³⁵] (*Scolipede*; #545). As cases of semantic radical reduplication are quite rare in the corpus and do not reflect phonological reduplication, these orthographic effects were not investigated here.

Finally, we investigated potential correlations between tone and Pokémon characteristics. In the ensemble model, there were trending positive correlations between the 4th tone (a tone that falls from high to low, represented as 51 in Chao digits; see Duanmu 2002) and Pokémon power, evolutionary stage, and probability of occurring as a male: these correlations are illustrated in Figures. A similar association between 4th tone and male personal names was observed in Starr et al. (2018). This link between largeness and 4th tone may also be observed in the Mandarin lexicon more broadly: 4th tone is used for words including 大 [ta⁵¹] ‘big’; 巨 [tɕy⁵¹] ‘huge’; 灑 [xau⁵¹] ‘vast’; 重 [tʂoŋ⁵¹] ‘heavy’; and 碩 [ʂuo⁵¹] ‘large’. This raises the question of whether the association between 4th tone and certain Pokémon attributes arises purely from the use of words for ‘big’. Indeed, a common strategy in making more evolved Pokémon names in Mandarin is also to add one of the words for ‘big’. For example, Stage 2 比比鳥 [pi³⁵ pi³⁵ niau²¹⁴] (*Pidgeotto*; #017) evolves to Stage 3 by stripping the reduplicated 比 [pi³⁵] and adding 大 [ta⁵¹], to become 大比鳥 [ta⁵¹ pi³⁵ niau²¹⁴] (*Pidgeot*; #018). However, even excluding 大 [ta⁵¹], for which there are 32 instances in the Mandarin pokemonikers, the sound symbolic correspondences of 4th tone holds (it weakens, but remains significant). Notably, the 4th tone, which falls in pitch from 5 to 1, is the tone contour with the steepest slope in Mandarin (Xu 1997): we propose that this steep pitch drop is iconically linked with largeness. This iconicity may be related to the fact that f₀ dynamics can influence perceived duration (Lehiste 1976). In particular, dynamic f₀ induces a longer percept than flat f₀ (Yu 2010; Gussenhoven & Zhou 2013). To be sure, it is puzzling though that the rising tone is not linked to largeness in Mandarin, since rising f₀ tends to induce the longest perceived duration. More discussion on tone and iconicity is in §5.1.2.

4.3.2 Segmental quality

Of the consonant and vowel features tested, there was only one significant segmental effect that emerged from the ensemble model. More front vowels in a pokemoniker, including [i, y, e, æ, a, ai, əi, ɛ] tends to correlate with more powerful characters, shown in Figure 12.

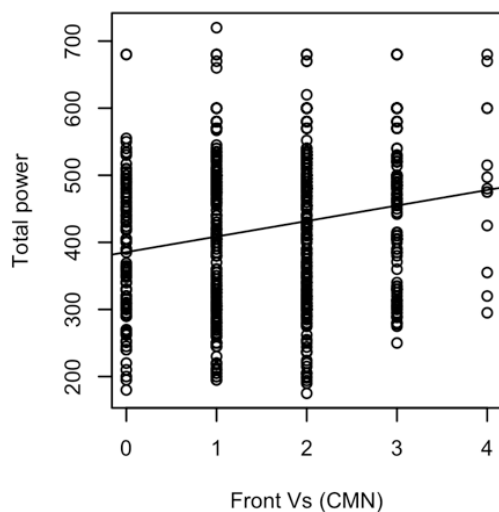


Figure 12. Correlations between number of front vowels (CMN) and Pokémon power.

Given that front vowels have been found to correlate with female personal names in Mandarin (Starr et al. 2018), as one would expect under the frequency code, this positive correlation between front vowels and power appears to be an anomalous finding.

4.4 Cantonese

Linguistic features that were examined in Cantonese are summarized in (5).

- (5) **Prosodic factors** syllables*, reduplication*, tone*
Vowel quality [+HIGH], [−HIGH][†], [+FRONT], [−FRONT]
Consonant quality [+ASPIRATION] obstruents, [−ASPIRATION] obstruents, syllable-final [p, t, k], [LABIAL], [VELAR, NASAL]

The results reported for Cantonese here are based on the original, pre-2016 set of Cantonese names (see fn. 7). In Cantonese, as with Mandarin, longer names are significantly correlated with heavier and more evolved Pokémon. The presence of reduplication is significantly correlated with lighter, smaller, less powerful, less evolved, and more commonly female characters.

4.4.1 Prosodic factors

In Cantonese, we find a significant negative correlation between 2nd tone (high-rising tone) and Pokémon size, power, and evolutionary stage. Names with more occurrences of 2nd tone are more likely to correlate with smaller, less powerful, and less evolved Pokémon, shown in Figure 13. Similar to the findings for 4th tone in Mandarin, 2nd tone in Cantonese is the tone with the steepest slope, rising from pitch 2 to 5 (Francis et al. 2008). While the falling tone in Mandarin was associated with largeness, this rising tone in Cantonese is linked to meanings related to smallness; indeed, this is the tone used in the word 小 [si:u²⁵] ‘small’. The association between 2nd tone and smallness might also be related to the fact that the diminutive and nickname formations in Cantonese are associated with a morphological tone change process, called *pin-jam*, that derives mid-to-high rising tones from semantically related syllables with a non-high level, non-mid rising tone: for example, [t^hoi²¹] ‘stage, terrace’ → [t^hoi²⁵] ‘table’; [kɛŋ³³] ‘mirror’ → [ŋan²³ kɛŋ²⁵] ‘eyeglasses’ (see Jurafsky 1988; Yu 2007). This tone change is also often associated with diminutive reduplication: for example, [je:²¹] ‘old man, paternal grandfather’ → [je:²¹ je:²⁵] ‘paternal grandfather (with endearment)’; [neq²³] ‘girl’ → [neq²⁵] ‘daughter’/[neq²³ neq²⁵] ‘daughter (with endearment)’ (see Yu 2012).

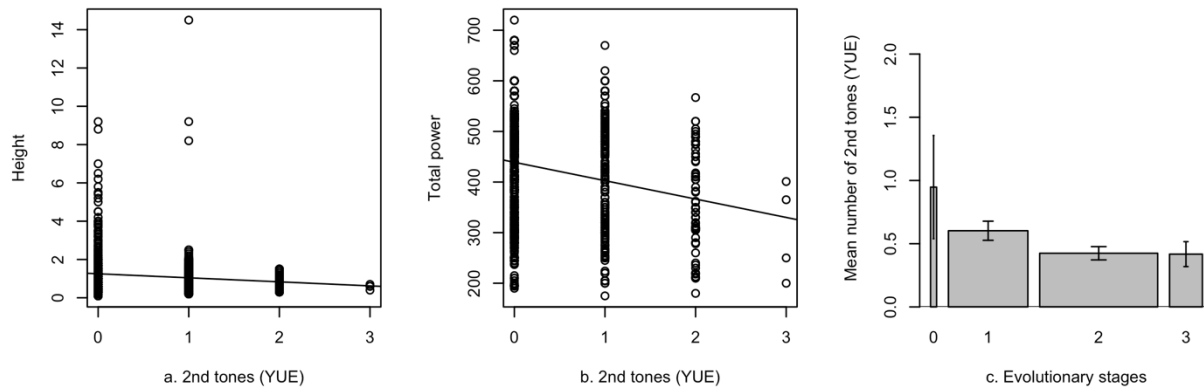


Figure 13. Correlations between number of 2nd tones (YUE) and Pokémon attributes (left to right): (a) height, (b) power, and (c) evolutionary stage (width of bars are scaled by proportion of data).

There is also a trending pattern of more 6th tones (low tones) correlating with a greater likelihood of being a male Pokémon. This is not a trend observed for personal names in Cantonese (Starr et al. 2018) but is nonetheless consistent with the predictions of the frequency code, where maleness is associated with lower pitch and deeper voices.

4.4.2 Segmental quality

There is a trending effect correlating the number of non-high vowels [a:, ɐ, ɛ̃, ɛ̃u, ɛ̃:, ɛ̃:u, ɔ̃, ɔ̃:y, œ:, e, ɛ̃y] in a name with Pokémon weight. Having more non-high vowels tends to correspond to lighter Pokémon. This runs counter to usual expectations of vowel height and weight (Shinohara & Kawahara 2010), and we do not necessarily have a fitting explanation of this effect. It is worth noting that Cantonese underwent a vowel shift from Middle Chinese, in which many high and low vowels swapped places (Newman 1983). If the vowel flip is responsible (in part or whole) for the effect here, it would suggest that sound symbolism is persistent even after surface sound-meaning correspondences are no longer true. Korean, discussed in the following section, also presents a potential situation in which historical shifts interact with sound symbolic associations.

4.5 Korean

Linguistic features that were examined in Korean are summarized in (6).

- (6) Prosodic factors segments*
Vowel quality “light” vowels [o, a], “dark” vowels [ʌ, u], [+HIGH], [−HIGH], [+FRONT], [−FRONT, −BACK]*, [+BACK], [ROUND]
Consonant quality tense obstruents*, aspirated obstruents, plain obstruents, [SONORANT] consonants, [NASAL], [LABIAL], [ALVEOLAR][†], [PALATAL], [VELLAR][†], palatalization environments (obstruent + [i, j])

4.5.1 Prosodic factors

Longer pokemonikers in Korean correlate most strongly with more powerful and more evolved Pokémon (with a trending correlation with heavier creatures).

4.5.2 Vowel quality

The most prominent sound-feature correspondence in the Korean pokemonikers are between central vowels and Pokémon characteristics. Having more central vowels [i, ʌ, a] in the name correlates with heavier, larger, and more powerful Pokémon (Figure 7).

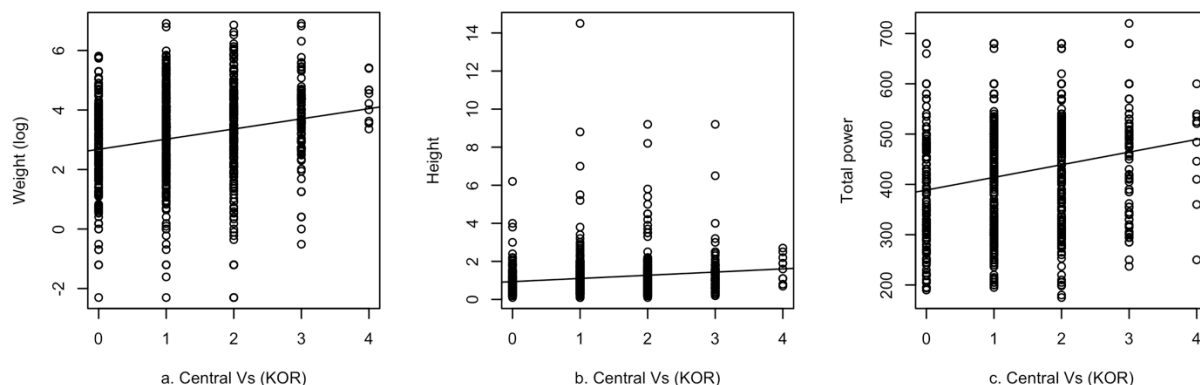


Figure 14. Correlations between number of central vowels (KOR) and Pokémon attributes (left to right): (a) weight, (b) height (size), and (c) power.

We did not find significant effects of light or dark vowels in the Korean pokemonikers (for background, see introduction in §1). In the simple correlation tests, light vowels did significantly correspond to lighter Pokémon. After controlling for other factors in the regression and classification tree models, however, light vowels did not emerge as significant in the final results. No significant correlations were found for dark vowels in the simple correlation tests. There are some pairs of Pokémon, however, that were noted to demonstrate the expected correlation with light and dark vowels: for example, Stage 1 탕구리 [tʰaŋguri] (KOR, #104) with a “light” vowel (bolded) evolves to the more powerful and larger Stage 2 탕구리 [tʰʌŋguri] (#105) with a “dark” vowel alternation (bolded).¹⁷

4.5.3 Consonant quality

Korean has a three-way stop contrast, between tense [Tʰ], aspirated [Tʰ], and unaspirated [T] stops. The distinction between unaspirated stops on one hand and tense and aspirated stops on the other is reported to correlate with sound symbolic qualities. Kim (1977:73) reports that aspirated and

¹⁷ Other pairs that demonstrate light-dark vowel correlations include the following:

- Stage 1 꿀깍몬 [kʰolkʰakmon] (KOR, #316) and Stage 2 꿀꺃깍몬 [kʰulkʰakmon] (#317)
- Stage 1 꼬오스 [koosi] (#92) and Stage 2 꼬우스트 [kousiti] (#93)
- Stage 1 꼬부기 [kʰobugi] (#7) and Stage 3 거북왕 [kʰʌbukwʌŋ] (#9)

tense stops demonstrate more intensity than plain stops: for example, /k/amahta ‘remote’ → /k’amahta ‘very remote’.

For pokemonikers, we find that more tense consonants in a name negatively correlates with height and power: having more tense consonants indicates a smaller and less powerful Pokémon (Figure 15). For example, Stage 1 미꾸리 [mik’uri] (KOR, #339) has a tense consonant whereas its Stage 2 evolution 메깅 [megiŋ] (#340) has a plain stop.¹⁸

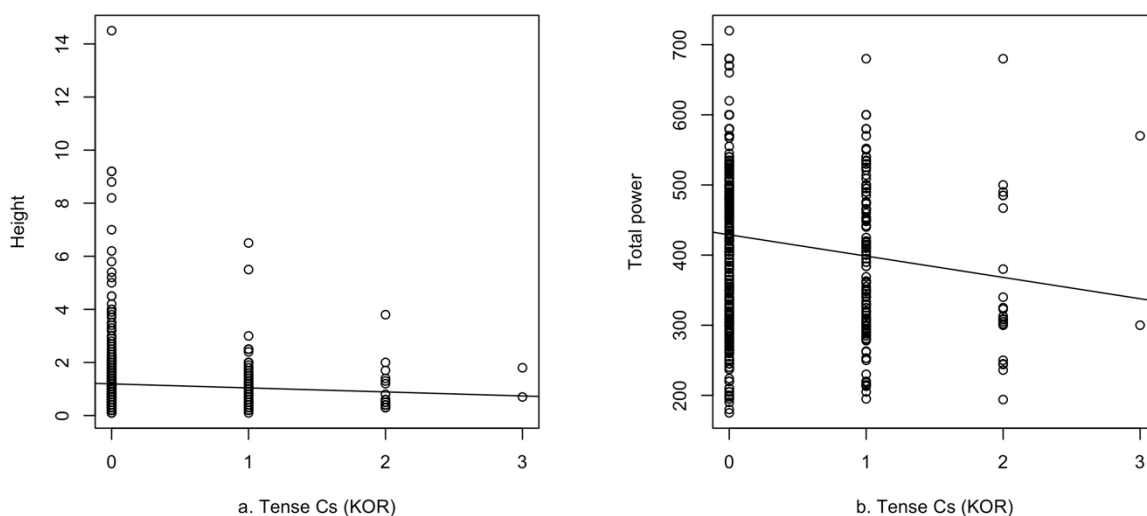


Figure 15. Correlations between number of tense consonants (KOR) and Pokémon attributes (left to right): (a) height (size) and (b) power.

While the sound symbolic correlation for tense stops in Korean pokemonikers does not follow Kim 1977’s previously reported pattern, tensification of consonants is regularly used in the contemporary Korean *aegyo* ‘cute speech’ register, where plain and aspirated stops are tensified to communicate cuteness: 좋아해 *coh.a.he* → 쪼아해 *cco.a.he* ‘I like you’ (e.g., Jang, to appear). Tense stops have also been shown in the literature to be the first amongst the three different types of stops to appear in Korean children’s speech (Kong et al. 2011).

In terms of voice onset time (VOT), Korean tensed stops are similar to English voiced stops because they have short VOT (e.g., Lisker & Abramson 1964). This superficial similarity might predict, given sound-symbolic patterns in other languages, that the short VOT stops in Korean would behave the same way as Japanese and English short VOT stops—that is, be positively correlated with weight. However, unlike English and Japanese, VOT alone does not distinguish the 3-way contrast for Korean stops. VOT only distinguishes tense stops from plain and aspirated stops. F0 (pitch) is instead a more reliable signal for the contrast between plain versus aspirated and tense stops: plain stops exhibit lower f0, and aspirated and tense stops exhibit higher f0 (e.g., Kang 2014). Neither VOT nor f0 independently mark the 3-way Korean stop contrast (e.g., Kim 2004), and other phonetic correlates may also contribute to the contrast, including subglottal and intraoral pressure (e.g., Dart 1987; Kingston & Diehl 1994). This crucial difference in consonantal contrasts between Korean and other languages studied here (i.e., English, Japanese) helps to

¹⁸ The two names in Korean are not etymologically related: 미꾸리 *mikkuri* derives from 미꾸라지 *mikkuraci* ‘mudfish’, where 메깅 *meking* is from 메기 *meki* + 왕 *wang* ‘catfish king’.

explain why the Korean pattern does not follow the expected positive correlation between short VOT stops and Pokémon size and power. It does not explain, however, exactly why the Korean tense stops are correlated with smaller and lighter Pokémon instead.

The answer may lie in f_0 associations, where tense stops usually demonstrate higher f_0 in contemporary Korean than their plain and aspirated counterparts (Silva 2006; Kang 2014; Lee 2018). The higher f_0 effect suggests that high tone in Korean may correlate with smaller creatures in the pokemonikers; such pitch correlations follow expected cross-linguistic sound symbolic hypotheses for tone (e.g., Ohala 1994).

The correlation between tense stops and size and power was the only significant consonantal effect in the pokemonikers. Other consonant qualities did demonstrate trending patterns: having more alveolar and velar consonants in a name correlated with increases in weight.

4.6 Russian

Linguistic features that were examined in Russian are given in (7). Differences in loanword adaptation from English are discussed in §5.2.

(7)	Prosodic factors	segments*
	Vowel quality	[+HIGH], [+LOW], [−HIGH, −LOW] [†] , [+FRONT], [−FRONT], [ROUND]
	Consonant quality	[+VOICE] obstruents, [−VOICE] obstruents, [SONORANT] consonants [†] , [LABIAL], [ALVEOLAR]*, [PALATAL], [POSTALVEOLAR], [VELAR]*, palatalized consonants

4.6.1 Prosodic factors

As with English, we find that longer Pokémon names in Russian correlate significantly with more evolved Pokémon.

4.6.2 Vowel quality

No significant vowel quality correlations were found for Russian—see discussion in 5.2.1. A trending effect was found between mid vowels and Pokémon gender: names with more mid vowels correlated with a greater likelihood of presenting as a male character.

4.6.3 Consonant quality

Two significant effects were found for consonant quality. Names with more alveolar consonants and more velar consonants correlated positively with increases in Pokémon weight, as shown in Figure 16. There were also trending correlations between names with more sonorant consonants and heavier and more evolved Pokémon.

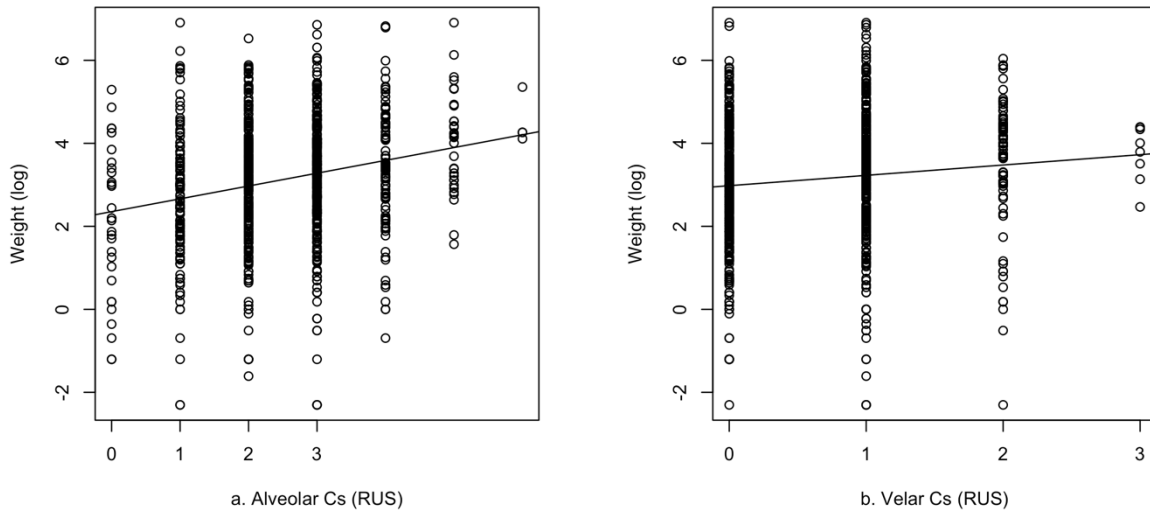


Figure 16. Correlations between Pokémon weight (log) and (a) number of alveolar consonants (RUS), (b) number of velar consonants.

5 Discussion: Cross-linguistic comparisons

This section considers the cross-linguistic similarities and differences in sound symbolism in pokemonikers.

5.1 Linguistic features: cross-linguistic commonalities vs. language-specific symbolisms

Which linguistic features participate in cueing symbolisms? Are they perceptuomotor analogies that are cross-linguistically shared, or are they language-specific phonological patterns?

We find in the Pokémon data that cross-linguistic perceptuomotor analogies lead to certain common linguistic features that frequently play a role in sound symbolism: word length correlating with Pokémon size, for instance. However, alongside these cross-linguistic patterns, we also find contributions of language-specific structure and experience.

For example, Japanese and English both feature two sound-meaning correlations using consonantal qualities: names with more voiced obstruents correlate with heavier Pokémon, and names with more labial consonants correlate with lighter, smaller, and less powerful Pokémon. Overall, the Japanese sound symbolic correlations have stronger effect sizes than the English ones, and voicing and labiality also correlate with evolutionary stage in Japanese (but not in English). We examined the subset of data where English and Japanese names are not phonological similar ($n=614$), to see whether the sound symbolic effects for consonants in English derive entirely from the shared names with Japanese. In the dissimilar subset, we found that the voiced obstruent correlation weakens but remains significant. This parallels experimental evidence from Kawahara & Kumagai (2019) that English speakers demonstrate association of voiced obstruents and Pokémon evolution, but not as strongly as Japanese speakers. Similarly, Iwasaki et al. (2007) found that English speakers share some intuition between voicing and size in sound symbolism more generally, but not to the same specific extent that Japanese speakers have. In contrast, we found in the dissimilar subset that the labial consonant correlation in English weakens and drops out of

significance. We take this as evidence that English speakers are not as attuned to using labiality as a sound symbolic feature as Japanese speakers are. English does not apparently associate labial sounds as strongly with babies as Japanese does: unlike Japanese diaper names, for instance, English does have non-labial diaper names such as *Huggies* and *Luvs*. (We do not rule out here a possibility that a general correspondence between labials and babies may still exist in English.) The comparison between consonantal sound symbolisms in English and Japanese demonstrates that sound symbolic associations can be language-specific, namely learned from experience elsewhere in the language's sound-meaning correspondences.

5.1.1 Word length

Word length is possibly the most common phonological correlate to many Pokémon attributes across all of the languages in this study. Previous work suggests that it is generally one of the most common cross-linguistic features in sound symbolism (e.g., Hinton et al. 1994; Dingemanse et al. 2015), suggesting that word length may be a truly cross-linguistic, universal sound symbolic feature.

In the Pokémon data, we do not find any opposite effect of length: across all languages, increase in pokemoniker length always positively correlated (rather than negatively correlating) with Pokémon size, weight, power, and evolutionary stage. What is the source of such universality in using length in sound symbolism? One possibility is that the effect can be explained by the role of morphology in Pokémon evolution. Cross-linguistically, additive morphology is much more common than subtractive morphology. As such, adding more phonological material is the easiest way to evolve a Pokémon (e.g., hypothetical Stage 1 *Blom* → Stage 2 *Blommon* → Stage 3 *Blommonster*; or see actual Pokémon evolution case in Japanese: *giaru* #599 → *gigiaru* #600 → *gigigiaru* #601),¹⁹ even though we could imagine an evolutionary set based on subtraction: e.g., hypothetical Stage 1 *Blom* → Stage 2 *Blo* → Stage 3 *Bo*. While rare, subtraction does occur in the Japanese pokemonikers: for instance, Stage 1 *koratta* (#019) → Stage 2 *ratta* (#020), which involves stripping *ko-*, the Japanese prefix 小, meaning 'small'.

To test whether there are sound symbolic correspondences that are independent of evolution in the pokemonikers, we examined only Stage 2 Pokémon (the largest set; $n=370$). Amongst Japanese Stage 2 Pokémon, name length remains significantly correlated with weight and power. In English and in Chinese, the name length effect disappears for Pokémon weight, and name length only trends in its correlation with power, barely reaching significance. It appears, then, that the word length sound symbolic effect in Pokémon is most active in Japanese across Pokémon attributes. For the other languages, it is linked primarily to evolution (and likely, the morphological ease with which to evolve a character by addition rather than subtraction).²⁰

Even though word length is the most “universal” of sound symbolic effects that we found, it is nonetheless subject to language-specific structural differences. In particular, the most effective

¹⁹ Such monotonic morphological increase as in the hypothetical example here is not seen in the English pokemonikers. Note for the Pokémon #599–601, the English names involve an irregular morphological derivation: *Klink* → *Klang* → *Klinklang*.

²⁰ A possible but speculative explanation as to why Japanese may have more sound symbolic effects linked to word length is that Japanese has a lower information density (see Pellegrino et al. 2011) and is more agglutinative than, e.g., Chinese and English; consequently, regular exposure to more word-lengthening morphological processes in the language may predispose speakers to the viability of this feature for sound symbolism.

phonological correlate of word length varied by language. Moras in Japanese are the most effective measure of word length because it is difficult to add phonological material to a word in Japanese without increasing the number of moras: for example, the evolution of *kodakku* (JAP, #054) to *gorudakku* (#055) adds the mora *ru*. Adding any vowel or allowable consonant (nasal or geminate) would result in an obligatory mora increase, given the phonological structure of Japanese. In contrast, segments are the most effective measure of word length for English because it is possible to add additional segments to a word without increasing the number of prosodic units (i.e., syllables): for example, the same Pokémon set *Psyduck* [saɪ.dʌk] (ENG, #054) evolves to *Golduck* [gɔʊl.dʌk] (ENG, #055) simply through the addition of a consonant coda in the first syllable.

5.1.2 Tone and sound symbolism

The usual perceptuomotor analogy expectation for tone-based sound symbolisms is that high pitch (i.e., f₀) should correlate with smaller objects (e.g., Ohala 1984:4). This makes the prevalence of 4th tone and 2nd tone sound-attribute correlates in Mandarin and Cantonese pokemonikers, respectively, particularly interesting. Mandarin 4th tone is a high-falling tone; Cantonese 2nd tone is a high-rising tone (Bauer & Benedict 1997:133; Duanmu 2002:210). Given previously hypothesized pitch-meaning correspondences according to the frequency code, we might have expected instead, that the level H tone in both Chinese languages—that is, 1st tone—would be the sound-symbolic correlate in Pokémon names (i.e., that H tones would correlate with smaller Pokémon).

It is the case that both 4th tone in Mandarin and 2nd tone in Cantonese reach the highest f₀ peaks compared to the other tones, even if they are not level high all the way through (see e.g., f₀ plots in Xu 1997:67 and Francis et al. 2008:271–272). Another stand out difference in comparison to the other tones in the inventories of these two languages is that the Mandarin 4th and Cantonese 2nd tones exhibit the steepest pitch changes. Mandarin 4th tone has a steep drop from level 5 to 1, and Cantonese 2nd tone has a steep rise from level 2 to 5. This suggests the possibility that not only pitch itself but also the nature of the contour—especially the sharpness of the pitch slope—may mark a tone as salient for forming sound symbolisms. As alluded to earlier, psychophysical studies have found perceived duration lengthening effects associated with dynamic f₀, particularly relative to flat f₀. This association between dynamic f₀ and long duration percept is not perceptually compensated for in the same way as the association between perceived duration and tone height. While syllables with high tone tend to be produced as shorter than syllables with low tone cross-linguistically (Faytak & Yu 2011), listeners rate syllables with higher flat f₀ as longer than syllables with lower flat f₀, even when the syllables are identical in duration acoustically speaking (Yu 2010). Yet, while dynamic f₀ or contour tones are associated with long vowels or vowel lengthening (Gordon 2001; Zhang 2001), listeners do not appear to compensate for it in perception the same way they do when the f₀ height effects on perceived duration. That is, syllables with dynamic f₀ are perceived as longer than syllables with flat f₀, even when the syllables are identical in length acoustically. The tight mapping between dynamic f₀ and duration in both perception and production might have allowed speakers of tone languages to establish a strong association between dynamic f₀ and size, assuming duration differences are associated with physical size differences in the language. The appeal of a psychophysical explanation for the association between f₀ steepness and duration/size is limited, however, since such an explanation fails to explain why f₀ steepness is associated with largeness in one language (e.g., Mandarin), but smallness in another (e.g., Cantonese).

Another possible source of the Chinese language tone effects is that they arise from language-specific tone-meaning correspondences or behaviours. As discussed in §4.3.1, in Mandarin, words that mean ‘big’, such as 大 [ta⁵¹], often have fourth tone. Even though the Pokémon Mandarin 4th tone effect is shown above to be independent of names that use 大 specifically, prior experience with this sound symbolic association in speakers’ lexicons may predispose them to an association between 4th tone and larger/stronger characters (for an overview on learning of sound symbolism, see Sidhu & Pexman 2018). Similarly, as noted above, Cantonese 2nd tone is associated with diminutive morphology, especially in diminutive reduplication. Since diminutivization is a common process in Cantonese, the robust semantic association between 2nd tone and morphological diminutivization might have prompted Cantonese speakers to develop a sound symbolic relationship between the mid-high rising tone and diminutiveness.

While not obviously a tone effect, we also find a possible association between f₀ differences and Pokémon features in Korean (see discussion in §4.5.3), where tense consonants are negatively associated with Pokémon size and power. Since tense (and aspirated) stops in contemporary Korean usually feature higher f₀ than their plain counterparts, the Pokémon correlation may indeed be one that we expect under the frequency code hypothesis.²¹ Although many studies have examined the correlation between f₀ and the Korean tense/aspirated/plain contrast (e.g., Choi 2002; Kim 2004; Silva 2006), the f₀ slopes associated with these stops are underreported, so comparison to the Chinese tone effects here is fodder for future investigation.

5.2 Loanword adaptation

Russian pokemonikers are transliterations from English pokemonikers: they are not semantic-based nativizations, as the English, Chinese, and Korean names are. As such, Russian presents an interesting case study for how sound symbolisms may be preserved, added, or removed in the course of cross-linguistic loanword adaptation.

5.2.1 *Loss of vowel symbolisms*

In English, we found several sound symbolic vowel correlates to Pokémon features: names with more low and/or back vowels correlated with heavier, larger, more powerful, and more male Pokémon. In loanword adaptation to Russian, however, many of these vowel correlations are lost. The only remaining trending effect is a correlation between more mid vowels and greater likelihood of male presentation in gameplay.

Russian, with 5 phonemic vowels [i, e, u, o, a],²² has a smaller vocalic inventory than English, with about 14 vowels (depending on dialect). In the adaptation of pokemonikers, the mapping of English vowels to Russian vowels is done largely on the basis of orthographic spelling: the mappings for English monophthongs to Russian are given in Figure 17.

²¹ Note, however, the discussion in §4.5.3, wherein potential contributions of VOT in Korean stop contrast that may interact with any tonal distinctions.

²² [ɨ] is a phonetic variant of /i/ that occurs after non-palatalized consonants. Vowel reduction results in more phonetic qualities of vowels, such as [ə], [ʌ], [ɪ], and [ʊ].

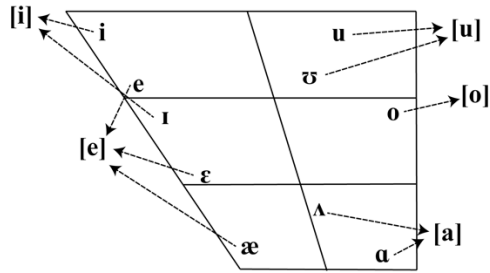


Figure 17. English monophthong to Russian vowel mapping (in stressed syllables). English vowels indicated without brackets; Russian vowels indicated with brackets.

The collapse of low and back distinctions, as shown in Figure 17, is sufficient to lose the sound symbolic correlations that we find in English. For instance, the low English vowel [æ] becomes the mid [e] in Russian, while the low [ɑ] remains low. The system of vocalic contrasts that is true of English is thus completely destroyed in Russian. This accounts for the fact that sound symbolic correlates that are true of English vowels do not hold. If we were to also take Russian vowel reduction into consideration, the differences would become even more drastic. In unstressed vowels, [o] and [a] neutralize to central vowels after non-palatalized consonants, and to front vowel [ɪ] after palatal or palatalized consonants (Timberlake 2004; Iosad 2012). High and front vowels [i] and [e] neutralize in non-palatalized contexts to [i̯], and in palatalized contexts to [i̯].

5.2.2 Consonantal qualities: neutralization and palatalization

Two consonant qualities in loanword adaptation between Russian and English were of particular interest: voicing neutralization and palatalization.

In loanword adaptation, Russian neutralizes coda voiced obstruents to voiceless. While this neutralization was previously thought to be categorical, recent literature has shown that incomplete neutralization does happen (e.g., Kharlamov 2014). For example, *code* is borrowed into Russian as /kod/, and surfaces mostly as [kot] (merging with [kot] ‘cat’ in Russian) but also as [kod] with incomplete voicing neutralization. In the pokemonikers, we also see examples of incomplete neutralization. *Charizard* (#006) is pronounced by our Russian consultants as [ʃerʲizart], with voicing neutralization, but *Girafarig* (#203) maintains its voiced coda in their pronunciations: [zɪrafarɪg]. Like English and Japanese, Russian does generally correlate voiced consonants with larger and louder items, though perhaps not to the same extent as other languages. For instance, Russian fireworks and explosions are mimicked by the sounds [b]am, [b]oom and [b]ax, but additional onomatopoeias for loud noises also include [t]rax, [t]ararax. Given the possibility of incomplete neutralization and the possibility of voicing-based symbolism in Russian, we wanted to know whether voicing could be maintained for Pokémon symbolism in English to Russian adaptation.

In English, we found that there was a correlation between consonant voicing and Pokémon weight (heavier Pokémon tend to have more voiced consonants). However, neutralization was enough to erase the significance of voicing correlates to weight in the Russian pokemonikers. Wilcoxon tests showed no significant differences in Pokémon attributes between the Russian pokemonikers that kept English consonant voicing and those that neutralized voicing. As such, we conclude that incomplete neutralization is not used in any sound symbolic way that we could find: that is, neutralization is not dependent on the Pokémon attributes that we have examined here.

If anything, the differences in consonant voicing between English and Russian reveal something about English sound symbolism. The loss of the sound symbolic correlation demonstrates that the English voicing effect lies mainly in coda consonants, because when word-final voicing (i.e., only voicing in word-final coda consonants and not in coda consonants in non-final positions) was lost in the borrowing to Russian, so was the sound symbolic effect. In contrast, the voicing effect in Japanese lies solely in the onset, since Japanese does not allow obstruents in coda position (except in gemination). English, too, has distributionally fewer contrasts in coda position than onset position: thus, the burden of sound symbolic correlation in coda positions (versus onset, as in Japanese) may explain the weaker effect between the two sets of pokemonikers. In fact, one possibility is that the voicing effect in English is not about consonantal voicing at all, but instead may be due to the lengthening of vowels before voiced codas (Kingston & Diehl 1994). In Russian, the effects of voicing are observed for consonant duration and glottal pulsing but not for preceding vowel duration (Kharlamov 2014), which offers a possible explanation for why voicing is not particularly salient in the maintenance of sound symbolic correlations between English and Russian pokemonikers.

Another potential locus of sound symbolic correlations in the transliteration of English pokemonikers to Russian is palatalization. In Russian, palatalization generally indicates smallness: for example, *lʲalʲa* is the child word for ‘baby’ or ‘doll’—in contrast, the adult term for ‘doll’ is *kukla*. This pattern follows the iconicity behaviour of palatalization cross-linguistically, where it is often associated with smallness, childishness, or affection (e.g., Ferguson 1977; Mester & Ito 1989; Hinton et al. 1994; Ohala 1994; Kochetov & Alderete 2011; Alderete & Kochetov 2016). We investigated possible correlations between palatal and palatalized consonants ([pʲ, bʲ, tʲ, dʲ, kʲ, gʲ, fʲ, vʲ, sʲ, zʲ, xʲ, mʲ, nʲ, lʲ, rʲ]) and Pokémon attributes, with the expectation that there should be correlations between palatalization and smallness. However, no effect was found.

Palatalization patterns in Russian pokemonikers are primarily orthography-driven. Invariably, all consonants before the orthographic <i> palatalize. Variation occurs in consonants before orthographic <e>, which can surface in loanwords as either palatalized or plain: e.g., *tempo* → [temp] or [tʲemp]. Both palatalized and plain consonants before <e> also occur in the Russian pokemonikers. For example, *Caterpie* (ENG; #010) is borrowed into Russian as [katɛrʲpʲi], with a plain stop [t] before the orthographic English <e> (bolded), and *Metapod* (ENG; #011) is borrowed as [mʲɛtʲapod], with a palatalized [m] before the orthographic <e>. Across all of the consonants, /t/ and /d/ show the least amount of palatalization before <e>. Based on a simple correlation test, there is a correlation between Pokémon weight and the number of palatalized consonants in a pokemoniker ($\rho = -0.103$; $p = 0.003$); however, the correlation was not strong enough to emerge in the ensemble model.

In sum, the Russian pokemoniker results suggest that when given the opportunity to introduce sound symbolic correspondences, faithfulness to the source language can still win out in loanword adaptation. Even in transliteration, there are possible locations where Russian sound symbolic preferences could have been introduced, but we did not find any evidence of such. In contrast, we find cases in Korean where sound symbolisms are introduced in the transliteration of Japanese pokemonikers. For example, in Japanese, Stage 1 Pokémon #035 and its evolved Stage 2 counterpart #036 are *Pippi* [pippi] and *Pixy* [pikushii], respectively. Their Korean pokemonikers are transliterations of the Japanese forms, but with differences in the initial stops: the Stage 1

Pokémon is [pʰipʰi] and the Stage 2 Pokémon is [pʰiksi].²³ As noted in §4.5.3, tensification in Korean is associated with more childlike, cute speech and, accordingly, smaller and less powerful Pokémon. Thus, here in Korean, we see a case in which a language’s “native” sound symbolic patterns are introduced during transliteration. The comparison between Russian and Korean pokemoniker transliteration also highlights another possible source for differences in Pokémon sound symbolisms: Russian’s Pokémon market is relatively new compared to the other markets investigated herein.

6 Discussion: Real-world attributes

As discussed in §1, certain real-world attributes are easier to imitate in linguistic modalities (e.g., spoken language more easily mimics sound; sign language more easily mimics movement, shapes, and functions) than others (e.g., abstract concepts are difficult to mimic). It appears not to be the case, however, that all real-world attributes are represented sound symbolically: if true, which real-world attributes do beget sound-symbolic correspondences?

While the current study does not provide any concrete answers to this aspect of sound symbolism, the results do suggest some pointers to which real-world attributes are most likely to link up to phonological forms. Our study finds that the Pokémon attributes that are more closely and robustly associated with phonological patterns are the ones that are more important to achieving game-specific goals. Reliably in our results, evolutionary stage and overall Pokémon power almost always have strong phonological correlates in all of the languages examined here. Both of these Pokémon attributes are critical to success in gameplay. Since the earliest versions of the game, power statistics determine how Pokémon characters will do against other characters during battle, which is a primary component of the game. Evolutionary stage represent the points at which Pokémon characters always change in appearance and almost always increase in power statistics, and at many points, gain significant new moves for battle.

In comparison, appearance statistics such as weight and height have regular correlations with phonological features in our study, but the correlations are weaker than those for power and evolution. To some extent, size can be indicative of power and evolution: when evolving, characters generally increase not only in power but also in size. However, as much as weight and height may add (visual) richness to the games, they have almost no functional role in that they do not influence battles, the moves that Pokémon can learn, or breedability, with a very few number of exceptions.²⁴ Finally, Pokémon gender has the least robust and fewest correlations with phonological features. This is in part surprising because male and female names are often distinguished by differential phonological patterns in languages (see overview in §1). In Pokémon gameplay, however, gender did not become relevant until the breeding of Pokémon was introduced in later generations of the game (Generation II and beyond). Breeding is now an integral part of the game,

²³ The baby Pokémon counterpart (#173) is *Py* [pi] in Japanese and is transliterated with a tense stop in Korean: [pʰi].

²⁴ In battle, there are two attacks (*low kick* and *grass knot*) that deal more damage the heavier the target Pokémon is. There are also two attacks (*heat press* and *heavy slam*) that deal more damage the heavier the user is than the target. One attack (*sky drop*) cannot be used to attack a Pokémon that is heavier than 200kg. There is a type of pokéball (*heavy ball*) that gets better at catching at Pokémon if that Pokémon is heavier. These are the only functional consequences of a Pokémon's weight.

It should also be noted that weight and height had no in-game function whatsoever in the first generation of the game.

especially for developing super-strong Pokémon for competitive battling with other players online. Gender, however, is not the only factor that is necessary in breeding: other Pokémon attributes not studied here, such as egg group and individual Pokémon power statistics, also contribute to breeding probabilities in the game. Thus, given the later introduction of breeding in core Pokémon gameplay, gender may not have warranted as many strong sound symbolic associations as other crucial attributes that were present since the start of Pokémon.²⁵ In comparison, knowing the sex of another person in the real world is crucial for evolutionary survival, and sound symbolic gender marking offers quick and highly useful cues about a referent's gender.²⁶

There are some factors that are highly important for Pokémon gameplay that we did not study here: in particular, Pokémon types. Each Pokémon has one or two type elements, of which there are 18 total types: *Normal, Fire, Water, Grass, Fighting, Flying, Poison, Electric, Ground, Psychic, Rock, Ice, Bug, Dragon, Ghost, Dark, Steel, Fairy*, and ???.^{27,28} Most types have been present since the inception of the Pokémon games. Types determine, in battle, which other Pokémon a given character is effective or ineffective against. For example, fire type Pokémon, such as *Charmander* (ENG, #004), are effective when fighting grass type characters, but are ineffective against water type characters. Given the discussion here, we might expect that such crucial characteristics of Pokémon to gameplay will beget sound symbolic correspondences; at the same time, the large number of distinct types may inhibit strong associations with phonological patterns (for exploratory work on this front for Japanese pokemonikers, see Hosokawa et al. 2018; Kawahara & Kumagai, to appear).

Another important aspect not studied here are the specific power statistics encompassed by the total power statistic measure: health points, attack, defense, special attack, special defense, and speed. These statistics represent very different considerations in the game: for example, health points determine how much life a character has and consequently how long a character will survive in battle, while speed determines if a character will attack first in battle. Thus, it is likely that each of these dimensions may have distinct and divergent sound symbolic correspondences, and in particular that the more salient power dimensions may have even more distinct or robust associations with phonological patterns. These avenues will be interesting to pursue in future research.

7 Conclusion

This paper presents the cross-linguistic study of sound symbolism across a dataset in which the cultural referents are constant but, crucially, the linguistic forms vary by language. A further advantage of the Pokémon universe is that the referents have clear, measurable features that, in the real world, are often more difficult to assess: for example, Pokémon strength can be measured in numbers via their assigned power statistics, whereas human strength and ability are more

²⁵ It is also worth noting that Pokémon characters of the same species but of different genders generally do not have different names: that is, a female or a male *Weedle* (ENG, #013) will always be referred to as *Weedle* in the game.

²⁶ It is not always the case for humans that game-relevant statistics beget sound symbolic correspondences: for discussion, see e.g., Shih & Rudin 2019 on potential correlations between baseball aptitude and human naming practices.

²⁷ The final type, ???, is now defunct in the game. No Pokémon species has ever had this type, and only one attack ever had this type.

²⁸ *Dark* and *Steel* types were introduced in Generation II, and *Fairy* was introduced in Generation VI. When *Steel* was introduced, two older Pokémon (*Magnemite*, ENG, #081 and *Magneton*, ENG, #082) were revised to gain the *Steel* type. When *Fairy* was introduced, 22 older Pokémon were revised to have the *Fairy* type either in addition to their old type or instead of one of their old types (e.g., *Marill*, #183, changed from *Water* to *Water/Fairy*; *Clefairy*, #035, changed from *Normal* to *Fairy*).

subjective qualities. Using this dataset, we address the questions about sound symbolism: Which linguistic forms correspond to real-world meanings or functions? What are the language-specific versus cross-linguistic sources of these correspondences? And, looking from the other direction, which real-world referents beget sound symbolic correspondences?

We find that several sound symbolic patterns in the pokemoniker data align our expectations of mimetic phonological patterns generally. For instance, long names—that is, names that are larger in size—regularly correspond to Pokémon that are also larger in size. And the prevalence of shared sound symbolic phonological representations across different languages also points to the perceptuomotoric sources that some of these sound symbolisms may have. But, we also find evidence that suggests that language-specific factors—including the phonologies of each particular language, or learning of the language’s existing lexical patterns—are at play in sound symbolic associations as well. Japanese pokemonikers, for example, have a robust association of labial sounds and more diminutive characters, which mirrors the prevalence with which such patterns already exist in the Japanese lexicon. Our results suggest that these language-specific factors interact with and, to an extent, color the cross-linguistic, perceptuomotoric associations between phonological forms and real-world (in this case, Pokémon) referents. Furthermore, characteristics of the real-word referents also contribute to sound symbolic associations: we find that certain Pokémon attributes are more robustly targets of sound symbolism than others. Looking forwards, a full understanding of non-arbitrary linguistic design will require the understanding of each of these interacting components in sound symbolism and their relationships. As we have shown here, “naturally”-occurring but also controlled datasets like the Pokémon universe names—while unconventional for linguistic data—offer valuable ecosystems for such investigations.

References

- ALDERETE, JOHN; and ALEXEI KOCHETOV. 2016. Integrating sound symbolism with core grammar: The case of expressive palatalization. *Language*.
- BARGARY, GARY; and KEVIN J. MITCHELL. 2008. Synaesthesia and cortical connectivity. *Trends in Neurosciences* 31.335–342. doi:<https://doi.org/10.1016/j.tins.2008.03.007>.
- BARTON, DAVID NICHOLAS; and JAMIN BRETT HALBERSTADT. 2018. A social Bouba/Kiki effect: A bias for people whose names match their faces. *Psychonomic Bulletin & Review* 25.1013–1020.
- BAUER, ROBERT S.; and PAUL K. BENEDICT. 1997. *Modern Cantonese Phonology*. Trends in linguistics, Studies and monographs 102. Berlin & New York: Mouton de Gruyter.
- BERGEN, BENJAMIN K. 2004. The Psychological Reality of Phonaesthemes. *Language* 80.290–311.
- BLASI, DAMIÁN E.; SØREN WICHMANN; HARALD HAMMARSTRÖM; PETER F. STADLER; and MORTEN H. CHRISTIANSEN. 2016. Sound-meaning association biases evidenced across thousands of languages. *Proceedings of National Academy of Sciences* 113.10818–10823.
- BREMNER, ANDREW J.; SERGE CAPAROS; JULES DAVIDOFF; JAN DE FOCKERT; KARINA J. LINNELL; and CHARLES SPENCE. 2013. “Bouba” and “Kiki” in Namibia? A remote culture make similar shape–sound matches, but different shape–taste matches to Westerners. *Cognition* 126.165–172. doi:10.1016/j.cognition.2012.09.007.
- CASSIDY, KIMBERLY WRIGHT; and MICHAEL H. KELLY. 1991. Phonological information for grammatical category assignments. *Journal of Memory and Language* 30.348–369. doi:10.1016/0749-596X(91)90041-H.
- CASSIDY, KIMBERLY WRIGHT; and MICHAEL H. KELLY. 2001. Children’s use of phonology to infer grammatical class in vocabulary learning. *Psychonomic Bulletin & Review* 8.519–523.
- CASSIDY, KIMBERLY WRIGHT; MICHAEL H. KELLY; and LEE’AT J. SHARONI. 1999. Inferring gender from name phonology. *Journal of Experimental Psychology: General* 128.362–381. doi:DOI:10.1037/0096-3445.128.3.362.
- CHANG, CHARLES B.; YAO YAO; ERIN F. HAYNES; and RUSSELL RHODES. 2011. Production of phonetic and phonological contrast by heritage speakers of Mandarin. *The Journal of the Acoustical Society of America* 129.3964–3980. doi:<https://doi.org/10.1121/1.3569736>.
- CHAO, YUEN-REN. 1930. A system of tone-letters. *Le Maître Phonétique* 45.24–27.
- CHO, YOUNG-MEE; and GREGORY IVERSON. 1997. Korean Phonology in the Twentieth Century. *Language Research* 33.687–735.
- CHO, YOUNG-MEE YU. 2006. Sound symbolism in Korean. *Korean Language in Culture & Society*, ed. by Ho-min Sohn, 64–73. Honolulu, HI: University of Hawai’i Press.

- CHOI, HANSOOK. 2002. Acoustic cues for the Korean stop contrast – dialectal variation. *ZAS Papers in Linguistics* 28.1–12.
- COPPOLA, MARIA; and DIANE BRENTARI. 2014. From iconic handshapes to grammatical contrasts: Longitudinal evidence from a child homesigner. *Frontiers in Psychology* 5.1–23.
- DART, SARAH N. 1987. An aerodynamic study of Korean stop consonants: Measurements and modeling. *Journal of Acoustical Society of America* 8.138–147.
- DAVIS, R. 1961. The fitness of names to drawings: A cross-cultural study in Tanganyika. *British Journal of Psychology* 52.259–268. doi:https://doi.org/10.1111/j.2044-8295.1961.tb00788.x.
- DINGEMANSE, MARK. 2012. Advances in the Cross-Linguistic Study of Ideophones. *Language and Linguistics Compass* 6.654–672.
- DINGEMANSE, MARK; DAMIÁN E. BLASI; GARY LUPYAN; MORTEN H. CHRISTIANSEN; and PADRAIC MONAGHAN. 2015. Arbitrariness, Iconicity, and Systematicity in Language. *Trends in Cognitive Sciences* 19.603–615.
- DINGEMANSE, MARK; WILL SCHUERMAN; EVA REINISCH; SYLVIA TUFVESSON; and HOLGER MITTERER. 2016. What sound symbolism can and cannot do: Testing the iconicity of ideophones from five languages. *Language* 92.e117–e133. doi:10.1353/lan.2016.0034.
- D’ONOFRIO, ANNETTE. 2014. Phonetic detail and dimensionality in sound-shape correspondences: Refining the Bouba-Kiki paradigm. *Language and Speech* 57.367–393.
- DUANMU, SAN. 2002. *The phonology of Standard Chinese*. Oxford, UK: Oxford University Press.
- ECCARIUS, PETRA; and DIANE BRENTARI. 2010. A formal analysis of phonological contrast and iconicity in sign language handshapes. *Sign Language & Linguistics* 13.156–181.
- ECKERT, PENELOPE. 2017. Comment: The most perfect of signs: Iconicity in variation. *Linguistics* 55.1197–1207.
- FARMER, THOMAS A.; MORTEN H. CHRISTIANSEN; and PADRAIC MONAGHAN. 2006. Phonological typicality influences on-line sentence comprehension. *Proceedings of the National Academy of Sciences* 103.12203–12208. doi:10.1073/pnas.0602173103.
- FAYTAK, MATTHEW; and ALAN C.L. YU. 2011. A typological study of the interaction between level tones and duration. *Proceedings of the International Congress of the Phonetic Sciences, XVII:659–663*.
- FERGUSON, CHARLES A. 1977. Baby talk as a simplified register. *Talking to children: Language input and acquisition*, ed. by Catherine E. Snow and Charles A. Ferguson, 209–235. Cambridge, UK: Cambridge University Press.
- FIRTH, JOHN RUPERT. 1930. *The Tongues of Men, and Speech*. London, UK: Oxford University Press.
- FRANCIS, ALEXANDER L.; VALTER CIOCCA; LIAN MA; and KIMBERLEY FENN. 2008. Perceptual learning of Cantonese lexical tones by tone and non-tone language speakers. *Journal of Phonetics* 36.268–294.
- GARRIGUES, STEPHEN L. 1995. Mimetic parallels in Korean and Japanese. *Studies in Language* 19.359–398.
- GASSER, MICHAEL; NITYA SETHURAMAN; and STEPHEN HOCKEMA. 2010. Iconicity in Expressives: An empirical investigation. *Experimental and Empirical Methods in the Study of Conceptual Structure, Discourse, and Language*, ed. by Sally Rice and John Newman, 163–180. Stanford, CA: CSLI Publications.
- GELMAN, ANDREW. 2008. Scaling regression inputs by dividing by two standard deviations. *Statistics in Medicine* 27.2865–2873.
- GORDON, MATTHEW. 2001. A typology of contour tone restrictions. *Studies in Language* 25.405–444.
- GUSSENHOVEN, CARLOS; and WENCUI ZHOU. 2013. Revisiting pitch slope and height effects on perceived duration. *Interspeech 2013*, 1365–1369. ISCA.
- HAMANO, SHOKO SAITO. 1986. *The Sound-Symbolic System of Japanese*. Gainesville, FL: University of Florida Ph.D. dissertation.
- HINTON, LEANNE; JOHANNA NICHOLS; and JOHN OHALA. 1994. Sound-symbolic processes. *Sound symbolism*, ed. by Leanne Hinton, Johanna Nichols, and John J. Ohala, 1–14. Cambridge, UK: Cambridge University Press.
- HOCKETT, CHARLES. 1959. Animal “languages” and human language. *Human Biology* 31.32–39.
- HOLLAND, MORRIS K.; and MICHAEL WERTHEIMER. 1964. Some physiognomic aspects of naming, or maluma and takete revisited. *Perceptual and Motor Skills* 19.111–117.
- HOSOKAWA, YUTA; NAHO ATSUMI; RYOKO UNO; and KAZUKO SHINOHARA. 2018. Evil or not? Sound symbolism in Pokémon and Disney character names. Poster. Paper presented at the 1st International Conference on Pokémonistics, Keio University, Tokyo, Japan.
- IMAI, MUTSUMI; SOTARO KITA; MIHO NAGUMO; and HIROYUKI OKADA. 2008. Sound symbolism facilitates early verb learning. *Cognition* 109.54–65. doi:10.1016/j.cognition.2008.07.015.
- IOSAD, PAVEL. 2012. Vowel reduction in Russian: No phonetics in phonology. *Journal of Linguistics* 48.521–571.
- ITŌ, JUNKO; and ARMIN MESTER. 1999. The phonological lexicon. *The Handbook of Japanese Linguistics*, ed. by Natsuko Tsujimura, 62–100. Oxford: Blackwell.
- IWASAKI, NORIKO; DAVID P. VINSON; and GABRIELLA VIGLIOCCO. 2007. What do English speakers know about gera-gera and yota-yota?: A cross-linguistic investigation of mimetic words for laughing and walking. *Japanese-Language Education around the Globe* 17.53078.
- JAKOBSON, ROMAN. 1978. *Six lectures on sound and meaning*. Cambridge, MA: MIT Press.
- JANG, HAYEUN. to appear. Register-specific phonology in core grammar: expressive strategies in Korean Aegyo. *Proceedings of the 26th Japanese/Korean Linguistics Conference*.
- JESPERSEN, OTTO. 1922. *Language: Its nature, development and origin*. London, UK: G. Allen & Unwin, Ltd.
- JOHANSSON, NIKLAS; and JORDAN ZLATEV. 2013. Motivations for sound symbolism in spatial deixis: A typological study of 101 languages. *The Public Journal of Semiotics* 5.3–20.

- JURAFSKY, DAN. 2013. Why ice cream sounds fat and crackers sound skinny. *Stanford Magazine*. <https://stanfordmag.org/contents/why-ice-cream-sounds-fat-and-crackers-sound-skinny>.
- JURAFSKY, DANIEL. 1988. On the Semantics of Cantonese Changed Tone or Women, Matches, and Chinese Broccoli. *Proceedings of the 14th Annual Meeting of the Berkeley Linguistics Society*, ed. by Shelley Axmaker, Annie Jaisser, and Helen Singmaster, 304–318. Berkeley, CA: Berkeley Linguistics Society.
- KANG, YOONJUNG. 2014. Voice Onset Time merger and development of tonal contrast in Seoul Korean stops: A corpus study. *Journal of Phonetics* 45.76–90. doi:10.1016/j.wocn.2014.03.005.
- KANTARTZIS, KATERINA; MUTSUMI IMAI; and SOTARO KITA. 2011. Japanese Sound-Symbolism Facilitates Word Learning in English-Speaking Children. *Cognitive Science* 35.575–586. doi:10.1111/j.1551-6709.2010.01169.x.
- KAWAHARA, SHIGETO; and GAKUJI KUMAGAI. to appear. Inferring Pokémon types using sound symbolism: The effects of voicing and labiality. *Journal of Phonetic Society of Japan*.
- KAWAHARA, SHIGETO; and GAKUJI KUMAGAI. 2019. Expressing Evolution in Pokémon Names: Experimental Explorations. *Journal of Japanese Linguistics* 3–38.
- KAWAHARA, SHIGETO; ATSUSHI NOTO; and GAKUJI KUMAGAI. 2018. Sound symbolic patterns in Pokémon names. *Phonetica* 75.219–244.
- KELLY, MICHAEL H. 1992. Using sound to solve syntactic problems: The role of phonology in grammatical category assignments. *Psychological Review* 99.349–364. doi:10.1037/0033-295X.99.2.349.
- KHARLAMOV, VIKTOR. 2014. Incomplete neutralization of the voicing contrast in word-final obstruents in Russian: Phonological, lexical, and methodological influences. *Journal of Phonetics* 43.47–56.
- KIM, KONG-ON. 1977. Sound symbolism in Korean. *Journal of Linguistics* 13.67–75.
- KIM, MIDAM. 2004. Correlation between VOT and F0 in the perception of Korean stops and affricates. *INTERSPEECH 2004*, 49–52.
- KINGSTON, JOHN; and RANDY DIEHL. 1994. Phonetic knowledge. *Language* 70.419–454. doi:10.2307/416481.
- KOCHETOV, ALEXEI; and JOHN ALDERETE. 2011. Patterns and scales of expressive palatalization: Typological and experimental evidence. *Canadian Journal of Linguistics* 56.345–376.
- KÖHLER, WOLFGANG. 1929. *Gestalt Psychology*. New York, NY: Liveright.
- KONG, EUN JONG; MARY E. BECKMAN; and JAN EDWARDS. 2011. Why are Korean tense stops acquired so early? The role of acoustic properties. *Journal of Phonetics* 39.196–211.
- KUMAGAI, GAKUJI; and SHIGETO KAWAHARA. 2017. How abstract is sound symbolism: Labiality and diaper names in Japanese. *Proceedings of the 31st Annual Meeting of the Phonetic Society of Japan*, 49–54.
- LEE, CYNTHIA. 2018. *The prosodic substrate of consonant and tone dynamics*. Los Angeles, CA: University of Southern California Ph.D. dissertation.
- LEHISTE, ILSE. 1976. Influence of fundamental frequency pattern on the perception of duration. *Journal of Phonetics* 4.113–117.
- LI, CHARLES N.; and SANDRA A. THOMPSON. 1989. *Mandarin Chinese: A functional reference grammar*. Berkeley, CA: University of California Press.
- LISKER, LEIGH; and ARTHUR ABRAMSON. 1964. A cross-language study of voicing in initial stops: Acoustical measurements. *Word* 20.384–422. doi:10.1080/00437956.1964.11659830.
- LOCKWOOD, GWILYM; and MARK DINGEMANSE. 2015. Iconicity in the lab: a review of behavioral, developmental, and neuroimaging research into sound-symbolism. *Frontiers in Psychology* 6. doi:10.3389/fpsyg.2015.01246. <https://www.frontiersin.org/articles/10.3389/fpsyg.2015.01246/full>.
- LUPYAN, GARY; and BODO WINTER. 2018. Language is more abstract than you think, or, why aren't languages more iconic? *Philosophical Transactions of the Royal Society B* 373.20170137. doi:<https://doi.org/10.1098/rstb.2017.0137>.
- MAURER, DAPHNE; THANUJENI PATHMAN; and CATHERINE J. MONDLOCH. 2006. The shape of boubas: sound–shape correspondences in toddlers and adults. *Developmental Science* 9.316–322. doi:10.1111/j.1467-7687.2006.00495.x.
- MESTER, ARMIN; and JUNKO ITO. 1989. Feature Predictability and Underspecification: Palatal Prosody in Japanese Mimetics. *Language* 65.258–293.
- MIURA, SATOSHI; MAKI MURATA; SHOO YASUDA; MAI MIYABE; and EIJI ARAMAKI. 2012. Onshoochoo-no kikaigakushuu-niyoru saigen: Saikyoo-no Pokemon no seisei [Replicating sound symbolism with machine learning: Generating the strongest Pokemon]. *Proceedings of The Association for Natural Language Processing* 18.
- MOK, WAICHUNG ENID. 2001. *Chinese Sound Symbolism: A Phonological Perspective*. Honolulu, HI: University of Hawai'i, Manoa Ph.D. dissertation.
- MONAGHAN, PADRAIC; MORTEN H. CHRISTIANSEN; and STANKA A. FITNEVA. 2011. The arbitrariness of the sign: Learning advantages from the structure of the vocabulary. *Journal of Experimental Psychology: General* 140.325–347.
- MONAGHAN, PADRAIC; RICHARD C. SHILLCOCK; MORTEN H. CHRISTIANSEN; and SIMON KIRBY. 2014. How arbitrary is language? *Philosophical Transactions of the Royal Society B: Biological Sciences* 369.20130299. doi:10.1098/rstb.2013.0299.
- NEWMAN, JOHN. 1983. Cantonese vowel shift. *Cahiers de linguistique Asie Orientale* 12.65–79.
- NEWMAN, PAUL. 2001. Are ideophones really as weird and extra-systematic as linguists make them to be? *Ideophones*, ed. by F. K. Erhard Voeltz and Christa Kilian-Hatz, 251–258. *Typological Studies in Language* 44. Amsterdam: John Benjamins.
- NEWMAN, STANLEY S. 1933. Further Experiments in Phonetic Symbolism. *The American Journal of Psychology* 45.53–75. doi:10.2307/1414186.

- NIELSEN, ALAN; and DREW RENDALL. 2011. The Sound of Round: Evaluating the sound-symbolic role of consonants in the classic takete-maluma phenomenon. *Canadian Journal of Experimental Psychology* 65.115–124. doi:10.1037/a0022268.
- NIELSEN, ALAN; and DREW RENDALL. 2012. The source and magnitude of sound-symbolic biases in processing artificial word material and their implications for language learning and transmission. *Language and Cognition* 4.115–125. doi:https://doi.org/10.1515/langcog-2012-0007.
- OHALA, JOHN J. 1984. An Ethological Perspective on Common Cross-Language Utilization of F0 of Voice. *Phonetica* 41.1–16. doi:10.1159/000261706.
- OHALA, JOHN J. 1994. The frequency code underlies the sound-symbolic use of voice pitch. *Sound symbolism*, ed. by Leanne Hinton, Johanna Nichols, and John J. Ohala, 325–347. Cambridge, UK: Cambridge University Press.
- OHYAMA, YUKA. 2016. *What can Pokémon names tell us about Japanese and English morphology and phonology?* London, UK: University College London M.A. thesis.
- OZTURK, OZGE; MADELAINE KREHM; and ATHENA VOULOUMANOS. 2013. Sound symbolism in infancy: Evidence for sound–shape cross-modal correspondences in 4-month-olds. *Journal of Experimental Child Psychology* 114.173–186. doi:10.1016/j.jecp.2012.05.004.
- PELLEGRINO, FRANÇOIS; CHRISTOPHE COUPÉ; and EGIDIO MARSICO. 2011. Across-language perspective on speech information rate. *Language* 87.539–558. doi:https://doi.org/10.1353/lan.2011.0057.
- RAMACHANDRAN, VILAYANUR SUBRAMANIAN; and EDWARD M. HUBBARD. 2001. Psychophysical investigations into the neural basis of synaesthesia. *Proceedings of the Royal Society of London. Series B: Biological Sciences* 268.979–983. doi:10.1098/rspb.2000.1576.
- RAMACHANDRAN, VILAYANUR SUBRAMANIAN; and EDWARD M. HUBBARD. 2005. The Emergence of the Human Mind: Some Clues from Synesthesia. *Synesthesia: Perspectives from Cognitive Neuroscience*, ed. by Lynn C. Robertson and Noam Sagiv, 147–190. New York, NY: Oxford University Press.
- ROGERS, SUSAN K; and ABRAHAM S ROSS. 1975. A cross-cultural test of the Maluma-Takete phenomenon. *Perception* 4.105–106. doi:https://doi.org/10.1068/p040105.
- SAPIR, EDWARD. 1929. A study in phonetic symbolism. *Journal of Experimental Psychology* 12.225–239.
- SAUSSURE, FERDINAND DE. 1915. *Course in general linguistics*. New York: McGraw Hill.
- SHIH, STEPHANIE S. 2018. Learning lexical classes from variable phonology. *ICU Working Papers in Linguistics 4: Selected Papers from Asian Junior Linguistics Conference 2*, ed. by Yuki Seo and Haruya Ogawa, 1–15. Tokyo, Japan: International Christian University. <http://id.nii.ac.jp/1130/00004363/>.
- SHIH, STEPHANIE S; and DENIZ RUDIN. 2019. On sound symbolism in baseball player names. Manuscript. University of Southern California, ms. lingbuzz/004689.
- SHINOHARA, KAZUKO; and SHIGETO KAWAHARA. 2010. A Cross-linguistic Study of Sound Symbolism: The Images of Size. *Proceedings of the 36th Berkeley Linguistics Society*, 396–410. Berkeley, CA: Linguistic Society of America. doi:http://dx.doi.org/10.3765/bls.v36i1.3926.
- SHINOHARA, KAZUKO; and SHIGETO KAWAHARA. 2013. The sound symbolic nature of Japanese maid names. *The proceedings of JCLA 13*, 183–193. Japan Cognitive Linguistics Association.
- SIDHU, DAVID M.; and PENNY M. PEXMAN. 2015. What’s in a Name? Sound Symbolism and Gender in First Names. *PLOS ONE* 10.e0126809. doi:10.1371/journal.pone.0126809.
- SIDHU, DAVID M.; and PENNY M. PEXMAN. 2018. Five mechanisms of sound symbolic association. *Psychonomic Bulletin & Review* 25.1619–1643. doi:10.3758/s13423-017-1361-1.
- SIDHU, DAVID M.; and PENNY M. PEXMAN. 2019. The Sound Symbolism of Names. *Current Directions in Psychological Science*.1–5. doi:DOI: 10.1177/0963721419850134.
- SIDHU, DAVID M.; PENNY M. PEXMAN; and JEAN SAINT-AUBIN. 2016. From the Bob/Kirk effect to the Benoit/Éric effect: Testing the mechanism of name sound symbolism in two languages. *Acta Psychologica* 169.88–99. doi:10.1016/j.actpsy.2016.05.011.
- SILVA, DAVID J. 2006. Acoustic Evidence for the Emergence of Tonal Contrast in Contemporary Korean. *Phonology* 23.287–308. doi:10.1017/S0952675706000911.
- SIMNER, JULIA. 2013. The “rules” of Synesthesia. *Oxford Handbook of Synesthesia*. doi:10.1093/oxfordhb/9780199603329.013.0008. <https://www-oxfordhandbooks-com.libproxy1.usc.edu/view/10.1093/oxfordhb/9780199603329.001.0001/oxfordhb-9780199603329-e-008>.
- SLATER, ANNE S.; and SAUL FEINMAN. 1985. Gender and the phonology of North American first names. *Sex Roles* 13.429–440.
- SPENCE, CHARLES. 2011. Crossmodal correspondence: A tutorial review. *Attention, Perception, and Psychophysics* 73.971–995.
- STARR, REBECCA LURIE; ALAN C.L. YU; and STEPHANIE S SHIH. 2018. Sound symbolic effects in Mandarin and Cantonese personal names and Pokémon names. Paper. Paper presented at the 1st conference on Pokémonistics, Keio University, Tokyo.
- TIMBERLAKE, ALAN. 2004. *A Reference Grammar of Russian*. Cambridge, UK: Cambridge University Press.
- WICHMANN, SØREN; ERIC W. HOLMAN; and CECIL H. BROWN. 2010. Sound symbolism in basic vocabulary. *Entropy* 12.844–858.
- WRIGHT, SAUNDRA K.; JENNIFER HAY; and TESSA BENT. 2005. Ladies first? Phonology, frequency, and the naming conspiracy. *Linguistics* 43.531–561.
- XU, YI. 1997. Contextual tonal variations in Mandarin. *Journal of Phonetics* 25.61–83.
- YIN-POOLE, WESLEY. 2011. Pokemon gamer interview. *Eurogamer*. <http://www.eurogamer.net/articles/2011-02-22-the-brains-behind-pokemon-black-and-white-interview?page=2>.

- YU, ALAN C.L. 2007. Understanding near mergers: The case of morphological tone in Cantonese. *Phonology* 24.187–214.
- YU, ALAN C.L. 2010. Tonal effects on perceived vowel duration. *Laboratory Phonology 10*, ed. by Cécile Fougeron, Barbara Kühnert, Mariapaola D’Imperio, and Nathalie Vallée, 151–168. Berlin & New York: Mouton de Gruyter.
- YU, ALAN C.L. 2012. Two patterns of reduplication in Washo. *Proceedings of the 34th Annual Meeting of the Berkeley Linguistic Society*, 365–378. Berkeley, CA: Berkeley Linguistics Society.
- ZHANG, JIE. 2001. *The effects of duration and sonority on contour tone distribution: Typological survey and formal analysis*. Los Angeles, CA: University of California, Los Angeles Ph.D. dissertation.