How to express evolution in English Pokémon names*

Abstract

This paper is a contribution to the studies of sound symbolism, systematic relationships between sounds and meanings. Specifically, we build on a series of studies conducted within a research paradigm called "Pokémonastics," which uses the Pokémon universe to explore sound symbolic patterns in natural languages. Inspired by a study of existing English Pokémon names (Shih et al. 2018), two experiments were conducted in which native speakers of English were provided with pairs of pre-evolution and post-evolution Pokémon characters, the latter of which were always larger. The participants were given two name choices whose members were systematically different in some phonological properties. The results show the following sound symbolic patterns to be productive: (1) names with higher segment counts are more likely to be associated with post-evolution characters than names with lower segment counts, (2) names containing [a] are more likely to be associated with post-evolution characters than names containing [i], (3) names containing [u] are more likely to be associated with post-evolution characters than names containing [i], and (4) names containing coronals are more likely to be associated with post-evolution characters than names containing labials. Overall, the current results suggest that phonological considerations come into play when English speakers name new creatures. Implications of the current results for the theories of sound symbolism are discussed throughout the paper.

1 Introduction

Modern thinking about languages more often than not assumes that the relationships between sounds and meanings are largely arbitrary (Hockett 1959; Saussure 1916). However, an increasing number of studies have identified systematic correspondences between sounds and meanings, patterns which are often referred to as "sound symbolism."[1] For example, speakers of many languages find words

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[1]Recent review articles on sound symbolism include Akita (2015); Cusky & Kirby (2013); Dingemanse et al. (2015); Hinton et al. (1994); Kawahara (2019); Lockwood & Dingemanse (2015); Nuckolls (1999); Perniss et al. (2010); Schmidtke et al. (2014); Sidhu & Pexman (2018); Spence (2011); Svantesson (2017).

containing [a] (e.g. [mal]) to seem larger than the words containing [i] (e.g. [mil]) (Berlin 2006; Coulter & Coulter 2010; Jespersen 1922; Newman 1933; Sapir 1929; Shinohara & Kawahara 2016). A recent extensive cross-linguistic study of basic vocabulary items by Blasi et al. (2016) shows that [i] is often used in words representing "small" in many languages.

Hinton et al. (1994: 1), one of the landmark studies of sound symbolism in modern linguistics, define sound symbolism as "the direct linkage between sound and meaning." While there are now various definitions and subtypes of sound symbolism (e.g. Hinton et al. 1994; Lockwood & Dingemanse 2015; Perniss et al. 2010), this paper broadly construes sound symbolism to be "systematic associations between sounds and meanings." As we will observe, however, the types of sound symbolism that the current paper explores are iconic in nature and demonstrably have their bases in the way we manipulate our speech.

Within the general research program on sound symbolism, a growing body of studies has shown that names are not chosen randomly, but instead certain types of sounds with particular phonological properties tend to be chosen to capture an aspect of the named object (or person). For example, it has been known for some time that male names and female names are typically characterized by different phonological features in English, some of which are sound symbolic (Brown & Ford 1961; Cassidy et al. 1999; Cutler et al. 1990; Sidhu & Pexman 2015, 2019; Sidhu et al. 2019; Sidorov et al. 2016; Slater & Feinman 1985; Whissell 2001; Wright et al. 2005). For instance, male names are more likely to contain obstruents than female names, whereas female names are more likely to contain sonorants than male names.

Within this research on sound symbolism in names, a series of recent studies have used the names of Pokémon characters to explore the nature of sound symbolism in natural languages (Godoy et al. 2019; Hosokawa et al. 2018; Kawahara et al. 2018; Kawahara & Kumagai 2019a; Kumagai & Kawahara 2019; Shih et al. 2018, 2019; Suzuki 2017)—a research paradigm that is now called "Pokémonastics." Pokémon is a game series which was released in 1996, and has been popular in many places of the world, especially among young children. In Pokémon games, players collect and train their own Pokémon characters, and battle with others. Pokémon characters are fictional creatures, each of which has weight, size, and various strength parameters. Pokémon characters undergo evolution, and when they do so, they generally get bigger, larger, and stronger (see Figure 1). Also, when they evolve, they are called by a different name. When these attributes are systematically analyzed against types of sounds used in their names, some systematic patterns emerge. For example, in the Japanese Pokémon names, voiced obstruents ([b, d, g, z]) are associated with Pokémon characters that are larger, heavier, stronger and more evolved (Kawahara et al. 2018). Names with higher mora counts are also associated with characters that are larger, heavier, stronger, and more evolved. These sound symbolic associations are demonstrably productive, as shown by experiments using new Pokémon characters and nonce names (Kawahara & Kumagai 2019a; Kumagai & Kawahara 2019).

Shih et al. (2018, 2019) point out an important advantage of using Pokémon names to study the universal and language-specific aspects of sound symbolism. One challenge to compare sound symbolic patterns across languages using real words is the fact that the set of denotations that are named differs across languages. To take a simple example, Japanese lacks a word corresponding to the English verb *to miss X*, and it has to resort to a phrasal expression "to be sad because X is not here." Japanese lexically distinguishes "big sister" and "young sister," whereas English does not. In the Pokémon universe, on the other hand, the set of denotations is fixed across different languages. This universe thus allows for systematic cross-linguistic comparisons using the same, controlled set of denotations.

As anticipated above and will be discussed in further detail below, some sound symbolic patterns seem to be iconic in nature and have their roots in the articulatory and/or acoustic characteristics of our speech. For example, there is a recurrent observation that the vowel [a] is judged to be larger than the vowel [i] (Sapir 1929 *et seq.*). This sound symbolic asymmetry can be attributed to the difference in oral aperture or the size of the resonance cavity in front of the tongue (Jespersen 1922; Sapir 1929). Alternatively, (psycho)acoustic properties of [a] may be such that they imply a large sound source or a large resonance cavity (Ohala 1994). This sort of sound symbolism is expected to be universal, shared across all languages, to the extent that an iconic cross-modal mapping between sounds and meanings is a general property of natural languages.[2] Evidence from the experiments targeting preverbal infants suggests that some sound symbolic patterns may indeed be not confined to specific languages (Imai et al. 2008; Maurer et al. 2006; Peña et al. 2011), although more case studies are warranted to firmly establish the universality of sound symbolism.

In contrast to those patterns that have a phonetic basis, there are patterns of sound symbolism that seem to be non-iconic and purely based on convention. A well-known example is a sequence of [gl] in English, which is used in many words that are related to "light" (e.g. *glow, glisten, glitter, gloam*), a pattern that is known as phonaesthemes (Firth 1930). Unlike the case of [a] implying objects that are larger than [i], there is no phonetic sense in which [gl] is related to the notion of light. While it seems reasonable to assume that phonetically-based, iconic sound symbolism can be universal, those sound symbolic patterns that lack such iconic bases are expected to be language-specific. That is, we would not expect the connection between [gl] and the notion of light to hold universally. This distinction—those that have an iconic basis and those that do not—thus may allow us to tease apart universal sound symbolic patterns and language-specific patterns, one of the important tasks for research on sound symbolism (see e.g. Dingemanse et al. 2015; Imai & Kita 2014; Iwasaki et al. 2007). In this paper we hope to contribute to this general issue by exploring those iconic sound symbolic patterns that have their bases in our speech behavior, or in our cognitive system.

Within the Pokémonastics research paradigm, the study by Shih et al. (2018) on the existing English Pokémon characters' names has identified various sound symbolic patterns. Their findings,

[2] In fact, it can be the case that sound symbolism is no more than a specific case of iconic cross-modal synesthetic correspondences that hold between different modalities (Bankieris & Simner 2015; Cusky & Kirby 2013; Spence 2011). If this is the case, then sound symbolism is a general property of human cognition.

which the current study heavily relies upon, are summarized in (1).

(1) Sound symbolic patterns of the existing English Pokémon names found by Shih et al. (2018)

a. The more segments the name contains, the stronger the Pokémon character is.

b. Those Pokémon characters whose names contain low vowels (e.g. [a]) tend to be larger and heavier.

c. Those Pokémon characters whose names contain alveolar consonants (e.g. [t, s]) tend to be larger and stronger.

d. Those Pokémon characters whose names contain voiced obstruents tend to be heavier.

Since the scope of Shih et al. (2018) is limited to existing names, whether these patterns hold productively in new names is yet to be examined. While some systematic experimentation with nonce words has been conducted within the Pokémonastics paradigm with Japanese speakers (Kawahara & Kumagai 2019a; Kumagai & Kawahara 2019) and Portuguese speakers (Godoy et al. 2019), no systematic experiments targeting English speakers has been reported. Therefore, the question of whether the sound symbolic patterns in (1) are productive, or merely limited to the existing Pokémon lexicon, remains unanswered. To address this gap, this paper reports two experiments that together test the productivity of the patterns in (1), as well as other sound symbolic patterns reported in the literature.

The larger goal, as stated above, is to explore to what extent phonetically/cognitively motivated iconic sound symbolic patterns hold across languages. We reiterate here that the Pokémon universe provides us with a unique opportunity to conduct cross-linguistic research with a nicely controlled set of denotations, both by way of corpus studies and experimentation (Shih et al. 2018, 2019). We hope that the current results, together with those from the previous Pokémonastics experiments, will form a useful resource for general studies of sound symbolism.

2 Experiment 1

2.1 Hypotheses tested

The first experiment was designed to test the four specific hypotheses in (2):

(2) Hypotheses tested in Experiment 1

a. Names containing voiced obstruents are more likely to be associated with larger Pokémon characters than names containing voiceless obstruents.

b. Names with higher segment counts are more likely to be associated with larger Pokémon characters than names with lower segment counts.

c. Names containing [a] are more likely to be associated with larger Pokémon characters than names containing [i].

d. Names containing [u] are more likely to be associated with larger Pokémon characters than names containing [i].

The first hypothesis was motivated by the finding by Shih et al. (2018) that those Pokémon characters whose names contain voiced obstruents tend to be heavier. This pattern may be related to a more general observation that voiced obstruents are associated with images of largeness and heaviness. This observation is well-studied in Japanese (Hamano 1996; Kawahara et al. 2008; Kubozono 1999; Shinohara & Kawahara 2016). This sound symbolic association is also known to hold in English (Iwasaki et al. 2007; Newman 1933; Shinohara & Kawahara 2016; Shih & Rudin 2019), and a recent elicitation study by Godoy et al. (2019) demonstrates that this sound symbolic effect emerges in the Pokémonastics experiment targeting Brazilian Portuguese speakers as well.

Kawahara & Kumagai (2019a) report one experiment in which English speakers were asked to compare pairs of nonce names, like *mureya* and *zuhemi*, and choose which nonce name better matches a large, post-evolution Pokémon character. Their results show that names containing a voiced obstruent (e.g. *zuhemi*) were more likely to be associated with post-evolution characters than names without voiced obstruents (e.g. *mureya*). However, the effect size was small (=55%), and moreover, their stimuli were Japanese-sounding words, consisting of three light syllables, which could have sounded unnatural to English speakers. An experiment which uses more English-sounding names was therefore warranted. Experiment 1 takes up this task as one of its aims.

The sound symbolic connection between voiced obstruents and images of largeness is arguably predicted by the Frequency Code Hypothesis (Ohala 1994), a general theory of sound-symbolic connections in natural languages. This hypothesis suggests that sounds with low frequency energy should be associated with something large, because this is what physics tells us—larger objects, when they vibrate, emit lower frequency sounds. Both in English and Japanese, vowels next to voiced obstruents show lower F0 and F1 compared to those that are next to voiceless obstruents (Kawahara 2006; Kingston & Diehl 1994).[3] Chodroff & Wilson (2014) demonstrate that English voiced stops characteristically have bursts with lower frequency than voiceless stops. The Frequency Code Hypothesis predicts that voiced obstruents, which show these low-frequency properties, should be judged to be larger than voiceless obstruents, both in English and Japanese (as well as in other languages, as long as voiced obstruents are characterized by low-frequency energy).[4]

The second hypothesis was motivated by the finding by Shih et al. (2018) that for the existing En-

[3]Here we follow Kingston & Diehl (1994) in assuming that at least phonologically, English obstruents contrast in voicing rather than in aspiration. Precise phonetic realizations of voiced stops in English, and how they may affect the sound symbolic values of these consonants, will be discussed in section 2.4.

[4]As proposed by Shinohara & Kawahara (2016), it may also be possible to attribute this sound symbolic association to the expansion of the oral cavity that is necessitated for the production of voiced obstruents (Ohala 1983; Proctor et al. 2010). This proposal too predicts that the association between voiced obstruents and images of largeness is universal, as the expansion of the oral cavity is caused by physical, aerodynamic requirements.

glish Pokémon names, the best predictor of Pokémon sizes and weights is segment counts, rather than mora counts or syllable counts (see Shih & Rudin 2019 for a similar observation in the set of Major League Base Ball players' names). A cross-linguistic study by Shih et al. (2019), targeting the existing Pokémon names in Cantonese, English, Japanese, Korean, Mandarin and Russian, shows that this length effect is what is most robustly attested across the target languages. While Kawahara & Kumagai (2019a) showed that English speakers tend to associate longer names with post-evolution characters, they only manipulated mora counts, not segment counts. The current experiment thus tests the productivity of the sound symbolic effect of segment counts.

The second hypothesis is related to the role of the "iconicity of quantity" in natural languages (Haiman 1980), in which longer words tend to represent something larger. An illustrative example is comparatives and superlatives in Latin (e.g., long(-us) "long" < long-ior "long-er" < long-issim(-us) "long-est"). According to Haiman (1980: 528), "generally speaking, the positive, comparative, and superlative degrees of adjectives show a gradual increase in the number of phonemes." This sound symbolic relationship identified by Shih et al. (2018) is thus cognitively motivated to the extent that it involves a straightforward iconic mapping between the length of a vector in one modality (name length) and the size of a vector in another (Pokémon size) (Marks 1978; Spence 2011). While this sound symbolic association seems to have a clear cognitive basis, this sort of iconic relationship has been understudied in natural languages,[5] and it is important to study how prevalent this pattern is in natural languages.

The third hypothesis is a re-examination of Sapir's (1929) finding—English speakers tend to associate the nonce word [mal] with a big table and the nonce word [mil] with a small table—in the context of naming Pokémon characters. This observation is very well-known in the literature on sound symbolism (Berlin 2006; Coulter & Coulter 2010; Jespersen 1922; Newman 1933; Sapir 1929; Shinohara & Kawahara 2016), and is also observed in the existing English Pokémon names. However, sound symbolic effects of vowel quality differences have not been tested experimentally using English Pokémon names, a gap this paper intends to fill. Two previous Pokémonastics experiments show that this sound symbolism is productive for Japanese speakers (Kumagai & Kawahara 2019) as well as for Brazilian Portuguese speakers (Godoy et al. 2019); if it can be shown that the same holds for English speakers, it contributes to establishing the cross-linguistic robustness of this sound symbolic pattern.

The third hypothesis, like the first hypothesis, is predicted by the Frequency Code Hypothesis. The intrinsic F0 of [a] is lower than that of [i] (Whalen & Levitt 1995), and thus this vowel should project larger images than does [i]. Conversely, [i] has high frequency energy, not only because of the

[5]There are some relevant studies in the research of ideophones, which are more sound symbolic than other lexical items (Akita & Dingemanse 2019; Dingemanse 2018). These studies focus on specific constructions like reduplication, in which reduplicated words denote larger quantity, and emphatic lengthening, in which lengthening of segments as in an expression like *it is sooooo long* denotes stronger commitment by the speaker to the proposition expressed (Dingemanse 2015; Dingemanse et al. 2015; Fuchs et al. 2019; Kawahara & Braver 2014; Mattes 2017).

intrinsic F0, but also because of the high second formant (F2).[6] Thus, this sound is associated with images of smallness, especially as compared to vowels like [a] which have both low F0 and F2.

The fourth hypothesis is not motivated by a sound symbolic pattern that is observable in the existing English Pokémon names; it was instead inspired by Berlin (2006), who argues, building on the Frequency Code Hypothesis, that front vowels are generally associated with images of smallness compared to back vowels in many different languages, because front vowels have higher F2 than back vowels. The Frequency Code Hypothesis predicts that [u], because of its low F2, should be better suited to represent large characters than [i], when English speakers name new Pokémon characters. Whether this sound symbolic effect can be active in the Pokémon universe is yet to be examined; the experiments with Brazilian Portuguese speakers did not show this effect of vowel backness very clearly (Godoy et al. 2019). In addition, this condition will allow us to address one general—and important—question regarding whether a sound symbolic pattern that is not observed in the existing names can emerge when naming new creatures.

2.2 Methods

2.2.1 Stimuli

Eight items were created to test each of the hypotheses in (2). The list of stimuli is shown in Table 1. The second author is very familiar with video games in English, and care was taken to create nonce names that were likely to be used as names for Pokémon characters. In the first condition, the pairs of names varied in the voicing quality of the first two consonants: one contained voiceless obstruents, whereas the other one contained voiced obstruents (e.g. *Toopen* vs. *Dooben*). Vowel quality was controlled within each pair. The second condition consisted of pairs of a short name and a long name. A long name had two extra consonants compared to the corresponding short name (e.g. *Kooten* vs. *Skoolten*). Since we are interested in the effects of phonological length, not morphological complexity, in order to prevent these extra consonants from being interpreted as a quasi-affix expressing evolution, at least one consonant was placed word-internally. Since English has a very limited set of infixes

[6]Shinohara & Kawahara (2016) show that F2 is a very good predictor of size ratings across four languages (Chinese, English, Japanese, and Korean). One general challenge to the Frequency Code Hypothesis is why F1 does not matter as much as F0 or F2. For example, since [a] has higher F1 than [i], this theory predicts [a] to be smaller than [i], if the judgment is based on F1. This puzzle is particularly challenging considering that F1 distributes around frequency ranges where our auditory system is most sensitive to (Johnson 2003). This problem is a general one—if F1 triggers size sound symbolism, as it does according to Knoeferle et al. (2017), then it predicts that there should be a general relationship between the lowness of the vowels and the smallness of their images, but such reports are unheard of (though see Diffloth 1994). To the best of our knowledge, this problem is not fully addressed in the previous literature on sound symbolism. It could be the case that duration may be an important factor to consider: generally, the lower the vowel, the longer the vowel (Lehiste 1970). This longer nature of low vowels may override the effect of F1 on size sound symbolism. The question, in short, is what types of acoustic information (both spectral and temporal) shape sound symbolic patterns in natural languages in what ways and how much. An additional question is whether we would expect differences across languages, especially if they use different sets of vowels. These issues have to be ultimately resolved with a series of cross-linguistic perception experiments with synthetic speech, which is beyond the scope of this paper.

(i.e. expletives, as in *im-fuckin'-possible*: McCarthy 1982), it was unlikely that these consonants were interpreted as affixes. In addition, two consonants were added; since English does not have a circumfix, it should be unlikely that these consonants were interpreted as an additional morpheme expressing evolution (although this possibility is further addressed in Experiment 2). Some types of onset clusters (*gl-, fl-, sn-, sl-, st-*), which may be considered as phonesthemes, were avoided. The third condition contained minimal pairs in which the first vowel varied between [i] and [a]. To avoid diphthongal reading, the first syllables were closed syllables (e.g. *Fifgor* vs. *Fafgor*). The fourth condition compared [i] and [u]—in this condition, [i] was expressed with orthographic "ee" and [u] with orthographic "oo" (e.g. *Teepen* vs. *Toopen*). For the third and fourth conditions, the non-initial vowels, as well as the consonants, were controlled within each pair.

Table 1: The list of stimuli for Experiment 1.

Voiced obstruents	Segment counts	[i] vs. [a]	[i] vs. [u]
Toopen vs. Dooben	Kooten vs. Skoolten	Fifgor vs. Fafgor	Teepen vs. Toopen
Tepott vs. Debott	Gashen vs. Grashren	Cilpon vs. Calpon	Geeband vs. Gooband
Peefair vs. Beevair	Motela vs. Smostela	Pitpen vs. Patpen	Peetgor vs. Pootgor
Pakoise vs. Bagoise	Bugol vs. Brulgol	Pidgor vs. Padgor	Keetair vs. Kootair
Taypoom vs. Dayboom	Pormite vs. Plortmite	Tidnea vs. Tadnea	Teeckott vs. Toockott
Toupino vs. Doubino	Povol vs. Provorl	Filgor vs. Falgor	Deepino vs. Doopino
Pukol vs. Bugol	Pooten vs. Spootren	Mistla vs. Mastla	Veegott vs. Voogott
Coparl vs. Gobarl	Cogela vs. Clorgela	Bilgol vs. Balgol	Geepigus vs. Goopigus

2.2.2 Task

The experiment was run online using SurveyMonkey (`https://www.surveymonkey.com`: last access, Jan. 2020). Within each trial, the participants were visually presented with a pair of pre-evolution and post-evolution Pokémon characters. To make clear to the participants that post-evolution Pokémon characters are larger, they were about 1.5 times larger than the pre-evolution versions. While Shih et al's (2018) study revealed correlations between particular sounds and several parameters such as weight and strength, the current experiment manupuliated size to highlight the difference between pre-evolution and post-evolution characters, because size is most easily conveyed to the participants. An example pair of the visual stimuli is given in Figure 1. These visual stimuli were non-existing Pokémon characters, which were drawn by a digital artist, *toto-mame*, whose Pokémon pictures are judged to be very authentic by Pokémon players.[7] These pictures are those that have been used in previous Pokémon naming experiments as well (Godoy et al. 2019; Kawahara & Kumagai 2019a; Kumagai & Kawahara 2019). In addition to making the post-evolution characters larger in

[7] These pictures were used with permission from the artist. Her website, where one can view other original Pokémon characters drawn by her, can be found at `https://t0t0mo.jimdo.com` (last access, Jan. 2020).

the visual prompts, it was explained to participants before the main trial that Pokémon characters generally get larger when they evolve.

Figure 1: An example of a visual stimulus pair. Left, pre-evolution character; right, post-evolution character. Neither of them are real existing Pokémon characters.

Within each trial, the participants were also provided with a pair of nonce names (those in Table 1), presented in English orthography.[8] The participants were asked to choose which name suited the pre-evolution character better and which name suited the post-evolution character better. The order of the two choices, as well as the order of the trials, was randomized for each participant. All the participants went through all the trials. After the main trials, the participants were asked how familiar they are with Pokémon using a 7-point scale; 1 was labelled "never touched it," 4 was labelled "so so" and 7 was labelled "Pokémon is my life."

2.2.3 Participants

The experiment was advertised on SNS (Social Networking Service) and through word of mouth. In total, 66 participants completed the online experiment. Six speakers were non-native speakers of English. Ten participants reported that they have studied sound symbolism. Two participants reported that they participated in an experiment in which they named Pokémon characters before. The data from these 18 speakers were excluded; the data from the remaining 48 native speakers were analyzed. There were no other particular restrictions, except that the participants had to be 18 years old or older.

[8] Since Pokémon names are often communicated in written forms in video games and card games, and since the previous Pokémonastics experiments used orthographic stimuli, the current experiment also used English orthography. An experiment with auditory stimuli may be warranted in future studies, however, given the known influences of orthography on sound symbolism (Cusky et al. 2017). See Sidorov et al. (2016) for the results demonstrating that sound symbolism holds beyond the possible influences of orthography.

2.3 Results

Figure 2 shows boxplots of the distributions of the expected response ratios for each condition by item (left) and by participant (right). White circles represent the grand averages, and thick grey error bars around the means represent the 95% confidence intervals. The grand mean expected response ratios were 0.61, 0.85, 0.75, 0.64 from left to right.

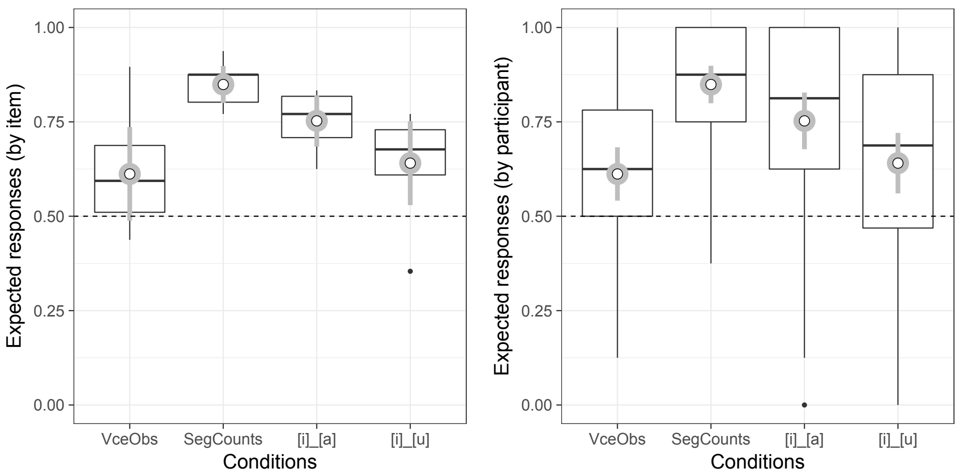

Figure 2: Expected response ratios for each condition by item and by participant. The grand means are shown with white circles. Grey thick error bars represent the 95% confidence intervals.

Following Daland et al. (2011), to assess the results statistically, each trial was split into two observations, each corresponding to one member of a stimulus pair.[9] A logistic linear mixed effects model was fit with each sound symbolic principle as a fixed factor and participant and item as random factors. A model with maximum random structure with both slopes and intercepts was fit (Barr 2013). The fixed factor was centered. All the conditions except for the first condition showed a significant effect of sound symbolism (segment counts: $z = 6.63, p < .001$: [a] vs. [i]: $4.85, p < .001$; [a] vs. [u]: $z = 2.34, p < .05$). The first condition showed results in the expected direction, but the difference was not significant ($z = 1.81, p = .07$).

One question that arises is whether these sound symbolic patterns are driven by exposure to existing Pokémon names, or whether the participants know, consciously or unconsciously, some sound symbolic principles independently of the exposure to Pokémon. If the former, those who are not familiar with Pokémon should not show high expected response ratios, whereas those who are very familiar with Pokémon can use their knowledge about existing Pokémon names, resulting in high

[9]Since each trial consisted of a pair of stimuli, this splitting was necessary to use a linear mixed effects model with items as a random effect. In their footnote 5, Daland et al. (2011) discuss various alternative analyses, and conclude that this is the best—albeit not flawless—strategy among all those that are currently available. To summarize their arguments in a nutshell, this analysis is implementable, interpretable and conservative.

expected response ratios. To address this question, Figure 3 plots the correlation between familiarity with Pokémon and expected response ratios for each condition.

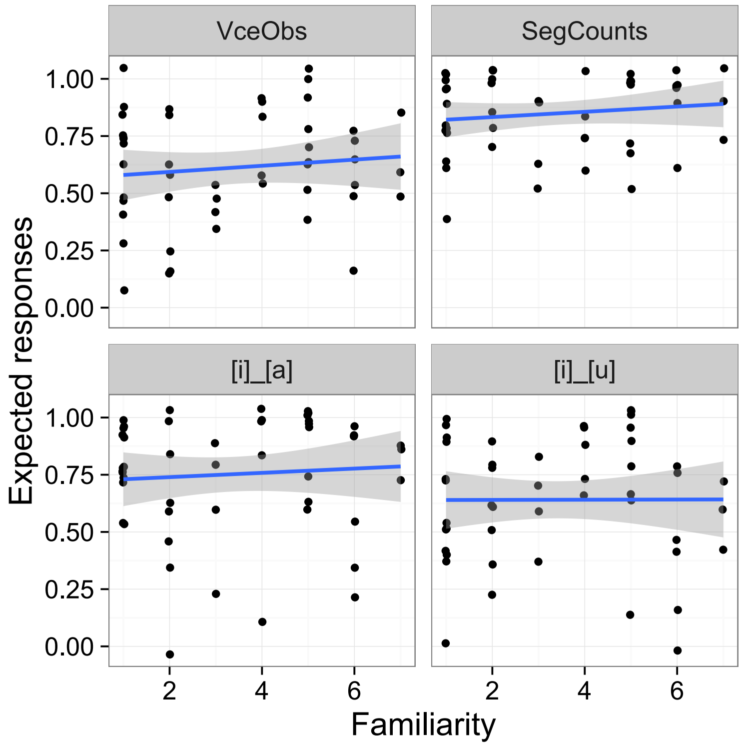

Figure 3: Correlation between familiarity with Pokémon and expected response ratios. The solid lines are linear regression lines. The grey areas represent the 95% confidence intervals.

None of the conditions shows a significant correlation between the two measures (non-parametric Spearman tests: $\rho = 0.06, n.s.$, $\rho = 0.14, n.s.$, $\rho = 0.09, n.s.$, and $\rho = 0.02, n.s.$).[10] Therefore, exposure to existing Pokémon names does not seem to have affected the results.

2.4 Discussion

The first condition did not show a significant effect of voiced obstruents, contrary to the previous findings with Japanese speakers (Kawahara & Kumagai 2019a). The fact that we did not observe a significant effect may be explainable in terms of the difference in how the laryngeal contrast is implemented between English and Japanese. Especially in word-initial positions, the "voiced stops" in English do not involve vocal fold vibration (Kingston & Diehl 1994; Lisker 1986). We expected that we may nevertheless observe an effect of voiced obstruents, since even word-initially, "voiced obstruents" show lower F0 and F1 compared to voiceless stops (Kingston & Diehl 1994), and they are characterized by bursts with lower frequency energy (Chodroff & Wilson 2014). Hence the Frequency

[10]Non-parametric Spearman tests were used because the familiarity scale was ordinal and hence non-continuous.

Code Hypothesis predicts that voiced obstruents should be judged larger than voiceless obstruents. The current results may imply that the effects of F0, F1 and burst energy may not be substantial enough to have resulted in systematic differences in size sound symbolism in the current context.[11] There also remains a question of why word-medial voiced stops did not cause images of largeness, as word-medial stops are fully voiced in English, with clear closure voicing with low frequency energy (Kingston & Diehl 1994; Lisker 1986). A possible explanation is that word-initial segments cause stronger sound symbolic images than word-medial segments (Kawahara et al. 2008) due to their psycholinguistic prominence (Hawkins & Cutler 1988; Nooteboom 1981), and hence the current results may have been largely driven by the quality of word-initial segments.

The second condition shows that there are robust effects of the "iconicity of quantity" in which longer words express something large (Haiman 1980)—simply put, "the longer the name, the larger the character." This condition has the highest expected response ratio among all the four conditions tested in the experiment. The iconicity of quantity may be a very robust sound symbolic principle that is operative when English speakers name new fictional creatures. Recall Shih et al.'s (2019) finding that this principle seems to be operative in the existing Pokémon lexicons of many languages. Taken together, this robustness leads us to expect that the iconicity of quantity may play a role in shaping phonological and lexical patterns in natural languages, outside of the Pokémon universe, more so than we currently know. This possibility should thus be explored in more depth in future exploration.

The third condition shows that the classic sound symbolic effect observed by Sapir (1929) can be replicated in the context of naming new Pokémon characters: [a] tends to be judged to be larger than [i]. As Sapir (1929) discusses, this sound symbolic effect may have its root in the articulatory properties of [a] and [i]—the oral aperture is much wider for [a] than for [i]—or in their acoustic properties—[a] has both lower F0 and F2 compared to [i]. The fact that the same sound symbolic pattern is observed in the naming of new Pokémon characters by Japanese and Portuguese speakers (Godoy et al. 2019; Kumagai & Kawahara 2019) shows that this sound symbolic effect is robust cross-linguistically.

The fourth condition shows that the degree of oral aperture cannot explain everything about vowel-related sound symbolism, because both [u] and [i] are high/closed vowels. At the very minimum, it shows that vowels' front/back distinction is relevant to sound symbolism. The direction is as expected from the Frequency Code Hypothesis; [u], being a back vowel, has lower F2 compared to [i], and hence [i] should be judged smaller than [u], as in the current result. Also recall that this sound symbolic asymmetry is not observed in the existing patterns of the English Pokémon lexicon (Shih et al. 2018), suggesting that phonetically motivated sound symbolic patterns can emerge when naming new fictional characters, despite the absence of evidence in existing Pokémon names.

[11] We note however that some previous experiments have shown that English speakers are sensitive to sound symbolic values of voiced obstruents (Iwasaki et al. 2007; Kawahara & Kumagai 2019a; Newman 1933; Shinohara & Kawahara 2016) (see also Shih & Rudin 2019 for evidence from a corpus study). Since the current result is in the expected direction, a follow-up study—possibly with more items and more participants—may reveal a clear effect of voiced obstruents.

3 Experiment 2

3.1 Hypotheses tested

Another experiment was run to address some questions that arose from the results of Experiment 1. Two additional sound symbolic effects were also tested in Experiment 2.

(3) Hypotheses tested in Experiment 2

a. The effect of segment counts holds for a pair of morphologically unrelated names.
b. Mora/syllable counts affect images of largeness in English, as in Japanese.
c. Names with coronal consonants are more likely to be associated with larger Pokémon characters than names with labial consonants.
d. Names with oral stops are more likely to be associated with larger Pokémon characters than names with fricatives.

In the second condition of Experiment 1, longer words were associated with larger, more evolved, Pokémon characters, supporting the role of the iconicity of quantity (Haiman 1980) in naming Pokémon characters. Although care was taken so that the extra consonants in longer names were not interpreted as morphemes expressing evolution, one cannot entirely deny the possibility that these consonants were interpreted as a circumfix (with one consonantal prefix and one consonantal infix) in Experiment 1. To address this alternative interpretation, the first condition of Experiment 2 randomly paired morphologically unrelated names. In this condition, the shorter condition had five segments, whereas the longer condition had seven segments (e.g. *Kuten* vs. *Clorgla*).

The second condition was designed to test the finding by Shih et al (2018) that segment counts, rather than mora or syllable counts, are the best predictor of Pokémon characters' status in English, unlike in Japanese for which moras play a crucial role. To examine this observation experimentally, the second condition controlled segment counts and varied mora counts (and accordingly, syllable counts). This condition consisted of pairs of names which share the same "root"; one member had an extra consonant at the beginning (e.g. *Skooten*), whereas the other member had an extra vowel (*Akooten*). If mora/syllable counts affect Pokémon characters' status, it is predicted that the latter names should be more likely to be associated with post-evolution characters, because they have one additional mora/syllable. On the other hand, if segment counts play a decisive role, then the response should distribute randomly.

The third condition was inspired by the observation by Shih (2018) that those Pokémon characters whose names contain alveolar consonants tend to be larger. This condition was additionally motivated by a recent finding that labials can be associated with images of being "babies", and accordingly, images of being small. In the existing names of Japanese Pokémon characters, the numbers of labials in the name are found to be associated with smaller size (Shih et al. 2018, 2019). While the tendency is much less clear, a similar effect is observed in the English Pokémon names, as shown by a later study (Shih et al. 2019). The sound symbolic values of labials are observed outside the context of Pokémon names as well. Kumagai & Kawahara (2020), for example, showed that Japanese speakers prefer to use labials when they are asked to come up with new diaper names, in comparison to when they are asked to name new adult cosmetics. They hypothesize that since labials are acquired at an early stage of language acquisition (see Ota 2015 for actual data from Japanese), observed both in babbling and early speech (Jakobson 1941; MacNeilage et al. 1997), they are associated with images of babies, hence smallness. Since this sound symbolic nature of labials is primarily studied targeting Japanese speakers (Kawahara & Kumagai 2019b; Kumagai & Kawahara 2020),[12] it was hoped that this condition will help us examine the productivity and cross-linguistic robustness of the pattern at issue.

The third condition of the experiment was designed to test whether this sound symbolic relationship may affect naming of pre- and post-evolution Pokémon characters for English speakers. The stimuli consisted of pairs of disyllabic nonce words; within each pair, one member contained labial onset consonants in the first two syllables, whereas the other member contained coronal consonants in the same position (e.g. *Paamair* vs. *Taanair*).[13] Vowel quality within each pair was controlled.

The final condition tested the opposition between fricatives and stops (e.g. *Suufen* vs. *Toopen*); again, vowel quality within each pair was controlled. Fricatives are generally acoustically characterized by energy in high frequency ranges (Johnson 2003), and therefore, the Frequency Code Hypothesis predicts that fricatives imply small creatures. Indeed, Coulter & Coulter (2010) show that when English speakers make judgments about price discounts, "sixty-six," which contains four fricatives, were judged to be smaller than "twenty-two," which contains no fricatives. The sound symbolic natures of the fricatives, as far as we are aware, are not very well-studied in linguistic studies, and thus we take this opportunity to test them in the current Pokémonastics experiment.

3.2 Methods

3.2.1 Stimuli

The stimuli of Experiment 2 are listed in Table 2. The target consonants appeared twice in the initial and second syllables in the third and fourth conditions.

[12]To the best of our knowledge, no studies directly explored the sound symbolic connections between labial consonants and images of size, but some studies have explored the sound symbolic values of labial consonants in English. D'Onofrio (2014), for example, found that [b] and [u], particularly its combination, are associated with round shapes.

[13]As an anonymous reviewer pointed out, labials are known to be associated with round figures, as in the classic *bouba-kiki* effect (D'Onofrio 2014; Ramachandran & Hubbard 2001), which could have affected the results. As seen in Figure 1, however, the pairs of Pokémon characters presented to the participants in the experiment did not differ much in terms of "angularity" or "roundness," and therefore we doubt that this shape-related sound symbolism substantially affected the results in the current experiment.

Table 2: The list of stimuli for Experiment 2.

Segment counts	Mora counts	Labial vs. coronal	Fricatives vs. stops
Kuten vs. Clorgla	Skooten vs. Akooten	Paamair vs. Taanair	Suufen vs. Toopen
Gashen vs. Spalpni	Grashen vs. Arashen	Pobol vs. Todol	Sefom vs. Tepom
Bugol vs. Sputren	Brugol vs. Erugol	Pormee vs. Tornee	Fathoil vs. Patoil
Pomit vs. Provorl	Spovol vs. Upovol	Meepen vs. Neeten	Fusol vs. Putol
Cogla vs. Skulten	Plooten vs. Elooten	Meepock vs. Neetock	Thieset vs. Tietet
Puten vs. Plotmit	Skogla vs. Ukogla	Bopol vs. Dotol	Thiesol vs. Tietol
Pepnu vs. Brulgol	Trepnea vs. Orepnea	Wilwol vs. Yilyol	Fosol vs. Potol
Cogla vs. Grashren	Pratodon vs. Oratodon	Wupol vs. Yutol	Soofal vs. Toopal

3.2.2 Task

The task and procedure were identical to Experiment 1.

3.2.3 Participants

In total, 51 native speakers of English participated in this experiment. The participants were recruited via "Buy Responses" option made available by SurveyMonkey. Data from one speaker was excluded because s/he reported that she had participated in a similar experiment before; data from two speakers were excluded, because they reported that they had studied sound symbolism. The data from the remaining 48 speakers entered into the following analysis.

3.3 Results

Figure 4 shows the boxplots of expected response ratios for each condition by item (left) and by participant (right). The grand means for each condition were 0.70, 0.53, 0.68 and 0.51 from left to right. Again a logistic linear mixed model was fit with the sound symbolic effect as the fixed factor and participants and item as random factors. The first condition, which examined the effects of segment counts, show response distributions above chance level ($z = 3.96, p < .001$). The second condition, which fixed the segment counts and varied mora counts, did not show substantial deviation from the chance level ($z = 0.49, n.s.$). The third condition showed that participants tended to associate coronals, rather than labials, with post-evolution levels ($z = 5.26, p < .001$). The fourth condition showed no significant deviation from chance level ($z = 0.21, n.s.$).

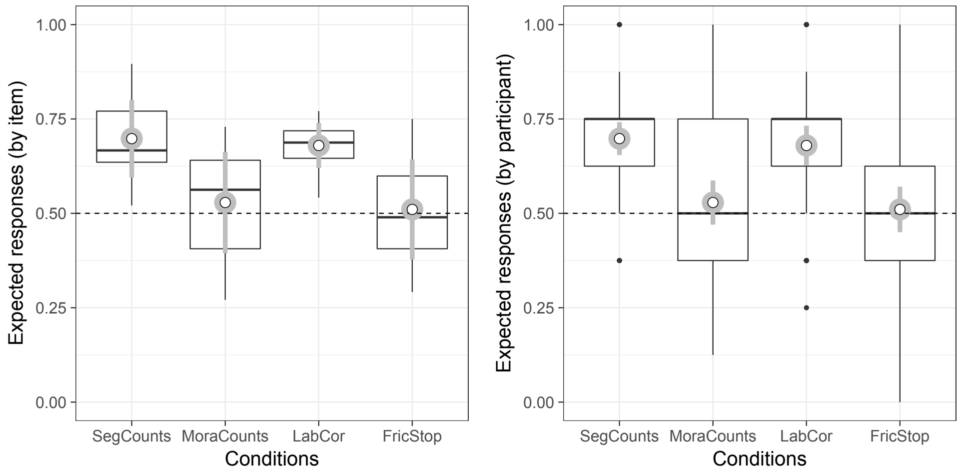

Figure 4: Expected response ratios for each condition by item and by participant (Experiment 2).

Figure 5 shows the correlation between familiarity with Pokémon games and expected response ratios for each condition. No conditions showed a significant correlation between familiarity and expected response ratios ($\rho = 0.02, n.s.$, $\rho = 0.02, n.s.$, $\rho = 0.02, n.s.$, and $\rho = -0.13, n.s.$). As with Experiment 1, exposure to actual Pokémon names does not seem to affect how susceptible each speaker is to the sound symbolic effects under investigation.

3.4 Discussion

The first condition shows the robustness of the iconicity of quantity, even when two names within a pair bear no morphological resemblance. In other words, phonological length, beyond morphological complexity, seems to affect images of largeness, at least when naming new Pokémon characters. Taken together with the results of Experiment 1, the role of the iconicity of quantity seems to be a very robust sound-symbolic principle that affects naming of new creatures for English speakers. As stated in the introduction, the role of the iconicity of quantity in phonological patterns is understudied. Given how robust the effect is, we expect that we may observe its activity in shaping other phonological and lexical patterns in natural languages.

The second condition controlled for segment counts and varied mora/syllable counts. The current result suggests that it is indeed segment counts, not mora or syllable counts, that impact images of largeness for English speakers. Four out of the eight vowel-initial stimuli contained initial [a] or [o], both of which are generally considered large (Newman 1933; Sapir 1929); nevertheless, they were no more likely to be associated with post-evolution characters than consonant-initial stimuli. This result further supports Shih et al's (2018) finding that segment count plays the most important role in the sound symbolic pattern of existing English Pokémon characters (see also Shih & Rudin 2019).[14]

[14]This is not to preclude the possibility that English speakers can use other measures such as mora/syllable counts when

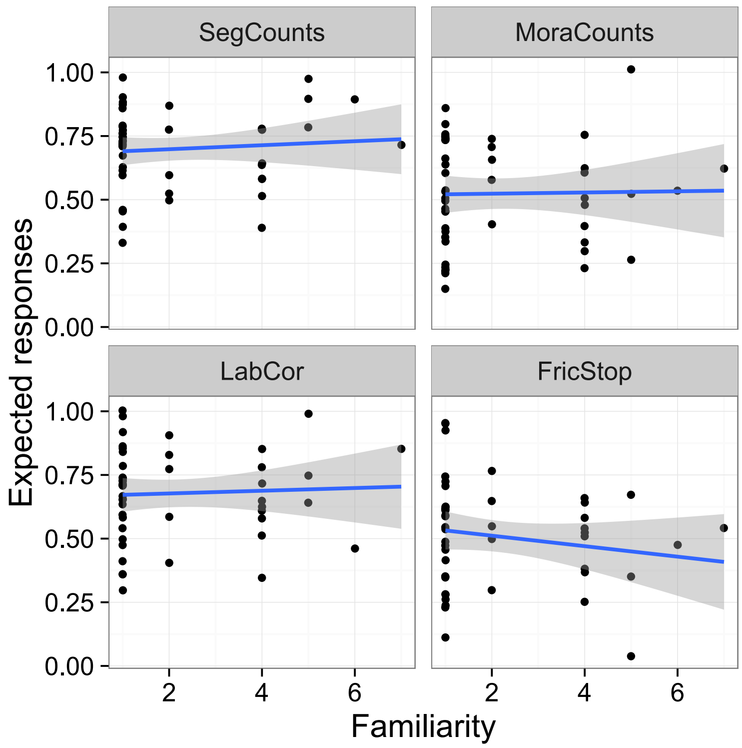

Figure 5: Correlation between familiarity with Pokémon and expected response ratios (Experiment 2).

Recall that Kawahara & Kumagai (2019a) found that Japanese speakers show sensitivity to mora counts, when they made judgments that are similar to the current participants. These findings point to an interesting difference between Japanese and English. In Japanese, one cannot increase segment count without increasing mora count, because consonants do not stand alone without a vowel (Ito 1989). Therefore, language-specific phonological constraints can result in different patterns of sound symbolism for English and Japanese.

The third condition showed that English speakers tended to associate coronals with post-evolution characters, as predicted by Shih et al. (2018), and associate labials with pre-evolution characters.[15] While there is an accumulating body of evidence that labials bear particular sound symbolic values for Japanese speakers (Kawahara & Kumagai 2019b; Kumagai & Kawahara 2020), not much was known

they deploy the iconicity of quantity to express sound symbolic meanings in other contexts.

[15]When we designed the experiment, we assumed that [w] is a labial glide and [j] is a coronal glide (see e.g. Clements & Hume 1995: 279 and Halle 2005). However, an anonymous reviewer pointed out that the phonological place specifications for the two glides [w] and [j] have been contested. For example, the IPA system considers [w] to be labio-velar (International Phonetic Association 1999), implying that it is both labial and dorsal (see also Nevins & Chitoran 2008). Palatal [j] may not only involve coronal articulation but also dorsal articulation (Nevins & Chitoran 2008; Keating 1988). As a post-hoc examination, we thus reanalyzed the results of this condition, which revealed that the results for the glide pairs were less clear than the results for the non-glide pairs (0.60 vs. 0.71)—it may thus be the case that the place of articulation of glides should not be treated on a par with the place of articulation of other consonants. We note, however, that both glides and non-glides showed the sound symbolic effects in the expected direction.

about speakers of other languages. The current result shows that English speakers too, like Japanese speakers, may associate labials with images of smallness, as compared to coronals at least. This sound symbolic association holds arguably because labials are those that are acquired early in language acquisition, frequently observed both in babbling and early speech (Jakobson 1941; MacNeilage et al. 1997). If this hypothesis is true, then we expect this sound symbolic effect to hold in other languages, which can be tested in future studies.

To the extent that labials can be associated with images of smallness, it shows that the Frequency Code Hypothesis does not dictate all sound symbolic patterns. This is because labials show energy concentration in low frequency ranges—they are grave consonants with low frequency burst energy and lowered formants in adjacent vowels (Stevens 1998; Stevens & Blumstein 1978). The current results thus contradict the prediction made by the Frequency Code Hypothesis. We can further conclude that instead of the Frequency Code Hypothesis dictating all the sound symbolic patterns, there must be multiple sources of sound symbolism (Sidhu & Pexman 2018). We hasten to add, however, that we are not suggesting that the Frequency Code Hypothesis should be abandoned as a general hypothesis for sound symbolism; our results just show that it does not dictate all the sound symbolic associations.

The fourth condition showed that fricatives are not necessarily associated with something smaller than stops, contra Coulter & Coulter (2010). It may be the case that while fricatives have high frequency energy, since voiceless stops involve complete silence, they can lead to images of smallness as well. One comparison that can be conducted in future research is fricatives vs. nasals, the latter of which have low frequency energy during constriction. Berlin (2006) in fact proposes that nasal consonants can imply something large, due to their low frequency energy. The experiment by Coulter & Coulter (2010) conflated vowel backness and a fricative/stop distinction in their stimuli—their "big" numbers were *two* with a stop and a back vowel, whereas their "small" numbers were *three* and *six*, both of which have front vowels and fricatives. If the current results are on the right track—positive effects of vowel frontness (Experiment 1) and null effects of a fricative/stop contrast (Experiment 2), it shows that it was a vowel front/back distinction that drove the results in their experiment.

In addition, this result shows that not all sounds with high frequency energy are associated with small images, contrary to the prediction of the Frequency Code Hypothesis. At least for the current results at hand, three consonant-related conditions did not support the Frequency Code Hypothesis (voiced obstruents and fricatives did not show expected results; labials showed a pattern that is opposite from what is expected from the Frequency Code). This result raises an interesting possibility: the Frequency Code may be solely about vowels (and tones/intonations), but not about consonants. A clear exception exists, however; palatals, characterized by high F2, are cross-linguistically associated with diminutive meanings (Alderete & Kochetov 2017). Reconciling these apparently conflicting observations need to be addressed in future studies.

4 Conclusion

While we have started understanding the sound symbolic nature of Pokémon names in a variety of languages (Shih et al. 2019), the productivity of these patterns is still only poorly understood. To fill that gap, the current study explored how active sound symbolic principles are in naming new Pokémon characters. To this end, the current studies have found the following sound symbolic patterns to be active in English:

(4)
a. Names with higher segment counts are more likely to be associated with large, post-evolution characters than names with lower segment counts (Experiments 1 and 2).
b. Names with [a] are more likely to be associated with post-evolution characters than names with [i] (Experiment 1).
c. Names with [u] are more likely to be associated with post-evolution characters than names with [i] (Experiment 1).
d. Names with coronals are more likely to be associated with post-evolution characters than names with labials (Experiment 2).

On the other hand, the following conditions showed null effects:

(5)
a. Names with voiced obstruents are no more likely to be associated with post-evolution characters than names with voiceless obstruents (Experiment 1).
b. When mora/syllable counts are manipulated while controlling for segmental counts, no effects of mora/syllable counts are observed (Experiment 2).
c. Names with stops are no more likely to be associated with post-evolution characters than names with fricatives (Experiment 2).

In both of the experiments, no substantial correlation was observed between the familiarity with Pokémon and the magnitude of the sound symbolic effects. These results imply that the observed patterns are not arising from the exposure to existing Pokémon names.

The robustness of the effect of segmental counts is interesting in that the cross-linguistic study by Shih et al. (2019) shows that in the corpora of existing Pokémon names, the effect of name length was what was most clearly observed across the target languages. The previous Pokémonastics experiments show that the length effect is observed with Japanese speakers (Kawahara & Kumagai 2019a) and Portuguese speakers (Godoy et al. 2019). Taken together, the current results suggest that the iconicity of quantity is a principle that very robustly holds in the Pokémon universe across different languages.

The finding that [a] and [u] are judged to be more suitable for post-evolution characters than [i] shows that English speakers are sensitive to vowel-related sound symbolism in the context of naming fictional creatures, at least as much as Japanese speakers (Kumagai & Kawahara 2019) and more so than Brazilian Portuguese speakers (Godoy et al. 2019), who did not show clear sensitivity to the vowel backness contrast. This comparison invites future studies comparing speakers of other languages to further examine the universality and language-specificity of vocalic sound symbolism patterns, as they are applied to naming fictional creatures.

Finding the potential sound symbolic effect of labials, as compared to coronals, with English speakers is important, as we only started understanding the extent to which this principle holds. Previous studies mainly focused on Japanese (Kawahara & Kumagai 2019b; Kumagai & Kawahara 2020). However, if this sound symbolic pattern is based on the observation that labials appear frequently in babbling and early speech, it does not come as a surprise if this association holds in other languages. The current study is one stepping stone toward examining the possible cross-linguistic robustness of this sound symbolic principle, and invites further studies on the sound symbolic values of labials in other languages.

Failing to find a robust effect of voiced obstruents may tell us something important as well; the effect of voiced obstruents in English may not be as substantial as in Japanese, because word-initial voiced stops in English do not involve glottal vibration, and the general low frequency properties of English voiced stops (low F0, F1 and burst energy) may not be sufficient to cause strong image of largeness for English speakers. This result opens up a new question for studies on sound symbolism—to what extent details of phonetic implementation affect sound symbolic patterns. A laryngeal contrast is phonetically realized differently across different languages (Cho & Ladefoged 1999). It would be of interest to explore how these differences lead to differences in sound symbolic patterns.

To summarize, we have confirmed the productivity of some previously known sound symbolic patterns (e.g. vowel related sound symbolism), some of which were not previously directly tested with English speakers (i.e. sound symbolic values of labials). While some of these sound symbolic patterns are observed in the existing Pokémon lexicon (e.g. [a] vs. [i]), some are not (e.g. [u] vs. [i]), suggesting that phonetically motivated sound symbolic patterns can emerge in experimental settings even in the absence of overt evidence in the Pokémon lexicon. The fact that we did not find correlation between the effect sizes and the familiarity with Pokémon further corroborates the conclusion that the present findings did not arise from familiarity with the distributional skews in the Pokémon lexicon. We also contributed to the understanding of how English speakers make use of the iconicity of quantity—they, at least in the context of naming Pokémon characters, use segment counts rather than mora/syllable counts. We have in addition found that some sound symbolic patterns that were proposed in the previous literature were not clearly observed in the context of naming new Pokémon characters (e.g. the effects of voiced obstruents and those of fricatives). Some patterns supported the Frequency Code Hypothesis, a general theory of sound symbolism, whereas others did not. The Frequency Code does not seem to dictate all the sound symbolic patterns in natural languages. Real questions that we should be addressing therefore seem to be: what are other principles, and how do they interact with the Frequency Code? All of these findings raise many questions that can only be fully answered by way of new experiments. We take this to be a positive result in that the current study opens up opportunities for future work in sound symbolism.

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