

# How to express evolution in English Pokémon names\*

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## 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 are systematically different in some phonological properties. The results show the following sound symbolic patterns to be productive: the English-speaking participants tend to associate large post-evolution characters with (1) names with more segments, (2) names containing [a], (3) names containing [u], and (4) names containing coronals. 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.”<sup>1</sup> For example, speakers of many languages find words 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 used in words representing “small” in many languages.

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<sup>1</sup>Recent review articles include Akita (2015); Cusky & Kirby (2013); Dingemanse et al. (2015); Hinton et al. (1994); Lockwood & Dingemanse (2015); Nuckolls (1999); Perniss et al. (2010); Sidhu & Pexman (2018); Spence (2011); Schmidtke et al. (2014); Svantesson (2017).

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 demonstrably have their bases in the way we manipulate our speech, or in clear iconic relationships between sounds and meanings.

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 (Brown & Ford 1961; Cassidy et al. 1999; Cutler et al. 1990; Sidhu & Pexman 2015, 2019; Sidhu et al. 2019; Slater & Feinman 1985; Whissell 2001; Wright et al. 2005), some of which are sound symbolic. 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. These generalizations are arguably rooted in a sound-symbolic relationship in which obstruents are associated with angular shapes, whereas sonorants are associated with round shapes (Köhler 1929; Lindauer 1990; Nielsen & Rendall 2011; Sidhu et al. 2019). This relationship between obstruents and angularity may have a basis in acoustic representations of obstruents—bursts and frication noise look, literally speaking, spiky and angular on waveforms (Jurafsky 2014; Kawahara & Shinohara 2012). On the other hand, the waveforms of sonorants look round, reflecting the periodic energy generated by vocal fold vibrations.

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<sup>2</sup> are also associated with characters that are larger, heavier, stronger, and more evolved.

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<sup>2</sup>Moras are psycholinguistically the most salient counting units in Japanese (Kubozono 1999a; Otake et al. 1993): CV

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 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 suboral 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 a cross-modal mapping between sounds and meanings is a general property of natural languages.<sup>3</sup> Evidence from the experiments targeting pre-verbal 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 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. Such sound symbolic patterns are expected to be language-specific. Teasing apart universal patterns and language-specific patterns is 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 sound symbolic patterns that have their bases in our speech behavior, or in our

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syllables contain one mora, and CVV or CVC syllables contain two moras. In the Japanese orthographic system, one mora generally corresponds to one *hiragana/katakana* letter. Moras can be defined for English phonology as well (Hammond 1999); while how to count moras may be less straightforward in English than in Japanese, for the current paper, what is crucial is the simple, uncontroversial assumption that vowels increase the mora count both in English and Japanese.

<sup>3</sup>In fact, it can be the case that sound symbolism is no more than a specific case of 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.

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

(1) Sound symbolic patterns of the existing English Pokémon names

- 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 not been reported. The question of whether the sound symbolic patterns in (1) are productive, or merely limited to the existing Pokémon lexicon, remains unanswered. To fill 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 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 with voiced obstruents are associated with larger Pokémon.
- b. Names with higher segment counts are associated with larger Pokémon.
- c. Names containing [a] are associated with larger Pokémon than names containing [i].

d. Names containing [u] are associated with larger Pokémons 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 1999b; Shinohara & Kawahara 2016). This sound symbolic association is also known to hold in English (Iwasaki et al. 2007; Newman 1933; Shinohara & Kawahara 2016), 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 post-evolution Pokémon character. Their results show that English speakers tend to associate names containing a voiced obstruent (e.g. *zuhemi*) with post-evolution characters, although the effect size was small (=55%). 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).<sup>4</sup> Chodroff & Wilson (2014) demonstrate that English voiced stops characteristically have bursts with lower spectral energies than voiceless stops. These low-frequency properties may lead to images of largeness in English and Japanese (as well as in other languages, as long as voiced obstruents are characterized by low-frequency energy).<sup>5</sup>

The second hypothesis is motivated by the finding by Shih et al. (2018) that for the existing English Pokémon names, the best predictor of Pokémon sizes and weights is segment counts, rather than mora counts or syllable counts. 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

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<sup>4</sup>We follow Kingston & Diehl (1994) in assuming that at least phonologically, English obstruents contrast in voicing rather than aspiration. Precise phonetic realizations of voiced stops in English will be discussed in section 2.4.

<sup>5</sup>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.

142 post-evolution characters, they only manipulated mora counts, not segment counts. The current ex-  
143 periment thus tests the productivity of the sound symbolic effect of segment counts.

144 The second hypothesis is related to the role of the “iconicity of quantity” in natural languages  
145 (Haiman 1980), in which longer words tend to represent something larger. An illustrative example is  
146 comparatives and superlatives in Latin (e.g., long(-us) “long” < long-ior “long-er” < long-issim(-us)  
147 “long-est”). According to Haiman (1980: 528), “generally speaking, the positive, comparative, and  
148 superlative degrees of adjectives show a gradual increase in the number of phonemes.” This sound  
149 symbolic relationship identified by Shih et al. (2018) is thus cognitively motivated to the extent that  
150 it involves a straightforward mapping between the length of a vector in one modality (name length)  
151 and the size of a vector in another (Pokémon size) (Marks 1978; Spence 2011). While this sound  
152 symbolic association seems to have a clear cognitive basis, this sort of iconic relationship has been  
153 understudied in natural languages,<sup>6</sup> and it is important to study how prevalent this pattern is in natural  
154 languages.

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

166 The third hypothesis, like the first hypothesis, is predicted by the Frequency Code Hypothesis.  
167 The intrinsic F0 of [a] is lower than that of [i] (Whalen & Levitt 1995), and thus this vowel should  
168 project larger images than does [i]. Conversely, [i] has high frequency energy, not only because of the  
169 intrinsic F0, but also because of the high second formant (F2).<sup>7</sup> Thus, this sound is associated with

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<sup>6</sup>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).

<sup>7</sup>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.

images of smallness.

The fourth hypothesis is not motivated by a sound symbolic pattern that is observable in the existing 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. 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 shown; the experiments with Brazilian Portuguese speakers did not show this effect 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 Method

### 2.2.1 Stimuli

Eight items were created to test each of the hypotheses in (2). The list of stimuli is listed in Table 1. The second author is very familiar with video games in English, and care was taken to create nonce names that are 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 is 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 (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]

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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 perception experiments with synthetic speech, which is beyond the scope of this paper.

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. Smotela    | 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>). 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 the current experiment manipulated 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.<sup>8</sup> 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 the visual prompts, it was explained to participants before the main trial that Pokémon characters generally get larger when they evolve.

Within each trial, the participants were also provided with a pair of nonce names (those in Table 1), presented in English orthography.<sup>9</sup> 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

<sup>8</sup>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>.

<sup>9</sup>Since Pokémon names are often communicated in written forms in video games and card games, and since the previous Pokémon naming experiments used orthographic stimuli, the current experiment also used English orthography. An experiment with auditory stimuli is warranted in future studies, however, given the known influences of orthography on sound symbolism (Cusky et al. 2017).



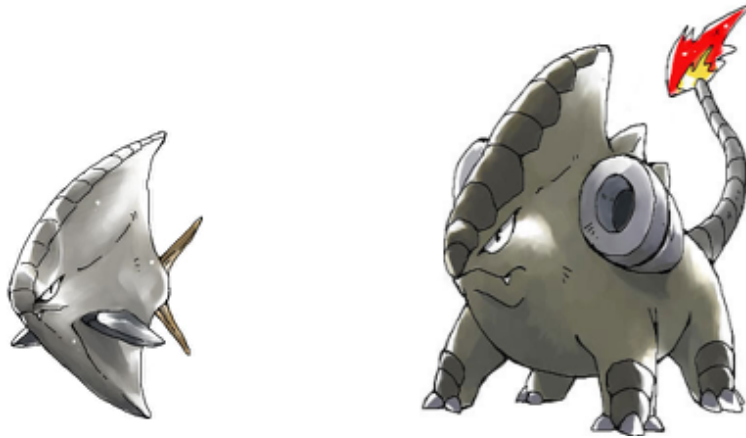


Figure 1: An example of a visual stimulus pair. Left, pre-evolution character; right, post-evolution character. Neither of them are real existing Pokémon characters.

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 services 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 speakers were analyzed.

## 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.

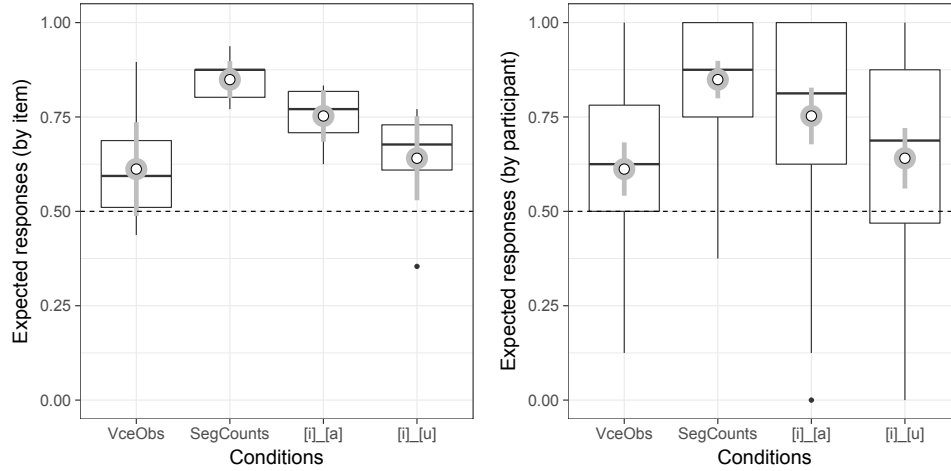


Figure 2: Expected response ratios for each condition by item and by participant. The grand means are shown with white circles. Grey thick error bars represent the 95% confidence intervals.

To assess the results statistically, following Daland et al. (2011), each trial is split into two observations, each corresponding to one member of a stimulus pair.<sup>10</sup> A logistic linear mixed effects model was fit with each sound symbolic principle as a fixed factor and subject and item as random factors. A model with maximum random structure with both slopes and intercepts was fit first (Barr 2013), and if the model converged, that model was interpreted (conditions 1, 2 & 4). In case it failed to converge, a simpler model with only random intercepts was interpreted (conditions 3). The fixed factor was centered. All the conditions except for the first condition showed a significant effect of sound symbolism (segment counts:  $z = 6.62, p < .001$ ; [a] vs. [i]:  $7.72, p < .001$ ; [a] vs. [u]:  $z = 2.34, p < .05$ ). The first condition showed results in the expected direction, but the difference missed significance ( $z = 1.81, p = .07$ ).

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

<sup>10</sup>Since each trial consists of a pair of stimuli, this splitting was necessary to encode 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.

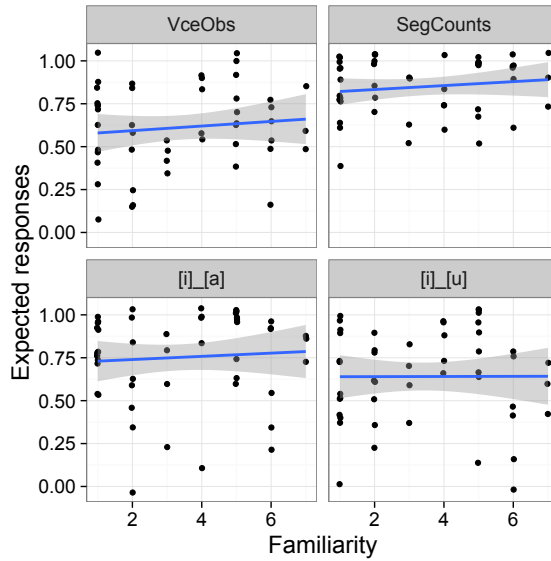


Figure 3: Correlation between familiarity with Pokémon and expected response ratios. The solid lines are linear regression lines. The grey areas represent the 95% confidence intervals.

None of the conditions shows a positive correlation between the two measures (non-parametric  $\rho = 0.06, n.s.$ ,  $\rho = 0.14, n.s.$ ,  $\rho = 0.09, n.s.$ , and  $\rho = 0.02, n.s.$ ).<sup>11</sup> Therefore, exposure to existing Pokémon names does not seem to have affected the results.

## 2.4 Discussion

The first condition showed a non-significant trend that goes in the direction that is expected from the previous findings with Japanese speakers (Kawahara & Kumagai 2019a). The fact that it did not reach significance 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 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.<sup>12</sup>

<sup>11</sup>Non-parametric tests were used because the familiarity scale was non-continuous.

<sup>12</sup>We note however that some previous experiments have shown that English speakers find voiced obstruents to be larger than voiceless obstruents (Iwasaki et al. 2007; Newman 1933; Shinohara & Kawahara 2016). 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.

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 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 “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] is larger than [i]. As Sapir (1929) discusses, this sound symbolic effect may have its root in the articulation of [a]—the oral aperture is much wider for [a] than for [i]—or in the acoustics—[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 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 names.

## 3 Experiment 2

### 3.1 Hypotheses tested

Another experiment was run to address some questions that arise 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. Coronals are associated with larger Pokémon compared to labials.
- d. Stops are associated with larger Pokémon compared to fricatives.

In the second condition of Experiment 1, longer words were associated with larger, more evolved, Pokémon characters, supporting the role of 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 are interpreted as a circumfix (with one consonantal prefix and one consonantal infix). To address this alternative interpretation, the first condition of Experiment 2 paired randomly paired, 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 rather randomly.

The third condition is motivated by Shih (2018) et al's observation that those Pokémon with alveolar (=coronal) consonants tend to be larger. This condition is also 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 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),<sup>13</sup> 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*). Vowel quality within each pair is controlled.

The final condition tested the opposition between fricatives and stops (e.g. *Suufen* vs. *Toopen*); again, vowel quality within each pair is 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 Method

### 3.2.1 Stimuli

The stimuli of Experiment 2 are listed in Table 2.

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. Provori  | 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.

<sup>13</sup>D’Onofrio (2014) for example found that [b] and [u], particularly its combination, is associated with round shapes. Monaghan et al. (2007) demonstrate that labials can be a stochastic cue to nouns in several languages.

### 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 subjects and item as random factors; only the fourth condition allowed us to include random slopes. The first condition, which examined the effects of segment counts, show response distributions above chance level ( $z = 10.65, p < .001$ ). The second condition, which fixed the segment counts and varied mora counts, did not show substantial deviation from the chance level ( $z = 1.59, n.s.$ ). The third condition showed skews toward associating coronals, rather than labials, with post-evolution levels ( $z = 7.00, p < .001$ ). The fourth condition showed no deviations from chance level ( $z = 0.21, n.s.$ ).

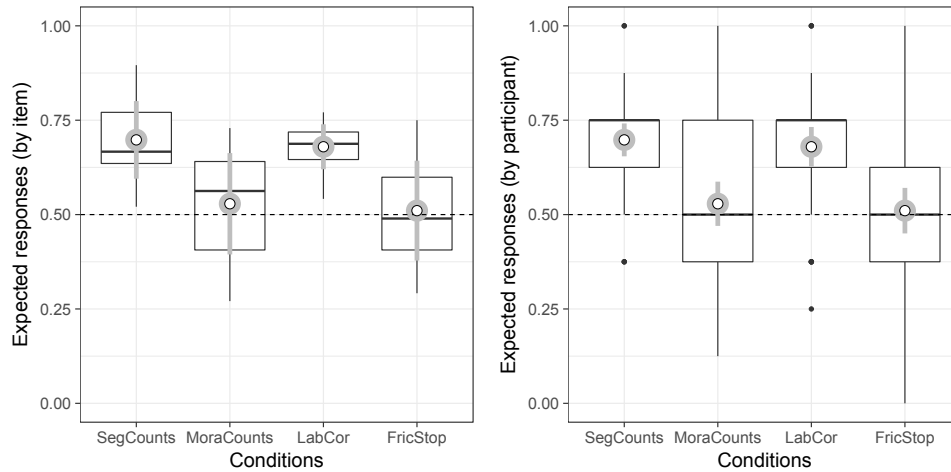


Figure 4: Expected response ratios for each condition by item and by participant.

Figure 5 shows the correlation between familiarity with Pokémon games and expected response ratios for each condition. No conditions show a positive 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.

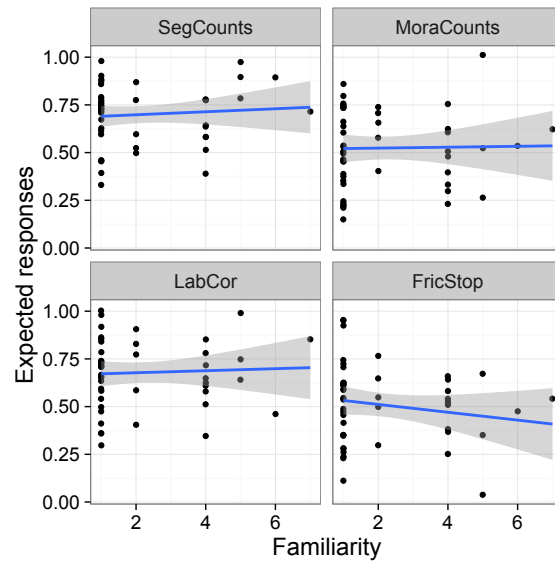


Figure 5: Correlation between familiarity with Pokémon and expected response ratios.



### 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 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 iconicity of quantity in phonological patterns is understudied. Given how robust the effect is, we expect that we would observe its activity in shaping the phonological and lexical patterns in natural languages.

The second condition controlled for segment counts and varied mora/syllable counts. The result suggests that it is indeed segment counts, not mora or syllable counts, that impacts 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 existing Pokémon characters in English.

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. One obvious topic for future research is to examine syllable-timing languages and explore whether they use syllables, rather than segments or moras, when deploying iconicity of quantity.

The third condition showed that English speakers tended to associate coronals with post-evolution characters, as predicted by Shih et al. (2018), and also associate labials with pre-evolution characters. 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 about speakers of other languages. The current result shows that English speakers too, like Japanese speakers, associate labials with images of smallness. 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; they in addition lower all formants of adjacent vowels (Stevens 1998; Stevens & Blumstein 1978).

Therefore, 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 is wrong; 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 lighter 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). This result raises an interesting possibility: the Frequency Code may be solely about vowels, 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.
- b. Names with [a] are more likely to be associated with post-evolution characters than names with [i].

- c. Names with [u] are more likely to be associated with post-evolution characters than names with [i].
- d. Names with coronals are more likely to be associated with post-evolution characters than names with labials.

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.
- b. When mora/syllable counts are manipulated while controlling for segmental counts, no effects of mora/syllable counts were observed.
- c. Names with stops were no more likely to be associated with post-evolution characters than names with fricatives.

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 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] is judged to be larger than [i] and [u] 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 a 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 sound symbolic effect of labials 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 the 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 led 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. [a] vs. [u]), suggesting that phonetically motivated sound symbolic patterns can emerge in experimental settings even in the absence of overt evidence in the lexicon. We also contributed to the understanding of how English speakers make use of the iconicity of quantity—they use segment counts rather than mora/syllable counts. We have also 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; a real question therefore is 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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