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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 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 coronal consonants are more likely to be associated with post-evolution characters than names containing labial consonants. Overall, the current results suggest that phonological considerations come into play when English speakers name new fictional 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

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are often referred to as "sound symbolism."[1] 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; 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 "smallness" 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; Sidhu & Pexman 2018), 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 and other languages, 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; Sullivan 2018; Whissell 2001; Wong & Kang 2019; 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. 2018a,b; 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 by Nintendo, 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 have them 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 for an illustrative pair). Also, when they evolve, they are called by a different name. When these attributes are 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

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

(Kawahara et al. 2018b). 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 et al. 2018a; 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" (*ane*) and "young sister" (*imooto*), whereas English does not have this lexical distinction. 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] (Jespersen 1922 and 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 pre-verbal infants suggests that some sound symbolic patterns may indeed be not confined to specific languages (Imai et al. 2008; Kantartzis et al. 2011; Maurer et al. 2006; Peña et al. 2011), although more case studies are warranted to firmly establish the universality of sound symbolism (see e.g. Fort et al. 2013 and Styles & Gawne 2017).

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 word-initial [gl] sequence in English, which is used in many words that are related to "light" (e.g. *glow, glisten, glitter, gloaming*), 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.

[2] In fact, it can even 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; Cuskley & Kirby 2013; Ramachandran & Hubbard 2001; Sidhu & Pexman 2018; Spence 2011). If this is the case, then sound symbolism is a general property of human cognition.

This distinction—those that have an iconic basis and those that do not—thus may allow us to tease apart universal sound symbolic patterns from 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, 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] and [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's (2018) study 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 et al. 2018a; 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 other Pokémonastics studies, 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 1998; 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; Shih & Rudin 2019; 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 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

[3] Here we follow Chodroff & Wilson (2014), Keating (1984), Kingston & Diehl (1994) and others 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.

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 English 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." The sound symbolic relationship in the existing English Pokémon names 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, to the best of our knowledge, 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; 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 (Kawahara et al. 2018a; Kumagai & Kawahara 2019) as well as for

[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 during 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.

[5]There are some relevant studies in the research of ideophones, which are more sound symbolic than other, prosaic lexical items (Akita & Dingemanse 2019; Dingemanse 2018). These studies, however, tend to 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).

Brazilian Portuguese speakers (Godoy et al. 2019); if it can be shown that the same result 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 intrinsic F0, but also because of the high second formant (F2).[6] Thus, this sound should be 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 observed 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 judged to 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 the whole 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 member

[6] Shinohara & Kawahara (2016) show that F2 is a very good predictor of size ratings across four different 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 can predict that [a] is judged 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-related 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 generally 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-related 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 to observe 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.

contained voiceless obstruents, whereas the other member 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 (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, March 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 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. Reproduced with permission from the drawer.

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

[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, March 2020).

[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. Yet, an experiment with auditory stimuli may be warranted in future studies given the possible influences of orthography on sound symbolism (Cuskley et al. 2017). See, however, Sidorov et al. (2016) for the results demonstrating that sound symbolism is likely to hold beyond the possible influences of orthography.

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.

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 averages represent the 95% confidence intervals. The grand average expected response ratios were 0.61, 0.85, 0.75, 0.64 from left to right.

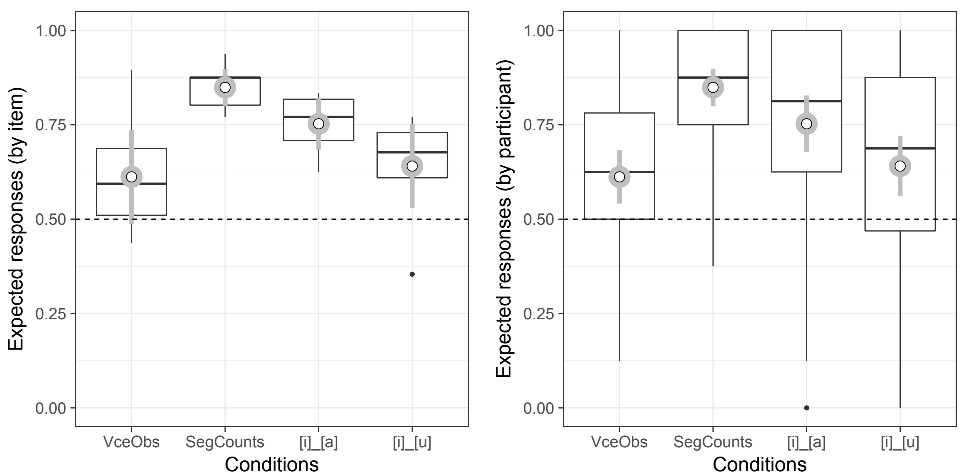

Figure 2: Expected response ratios for each condition by item (left) and by participant (right). The grand averages are shown with white circles. Grey thick error bars represent the 95% confidence intervals.

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; Barr et al. 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 ($z = 1.81, p = .07$).

[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.

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.

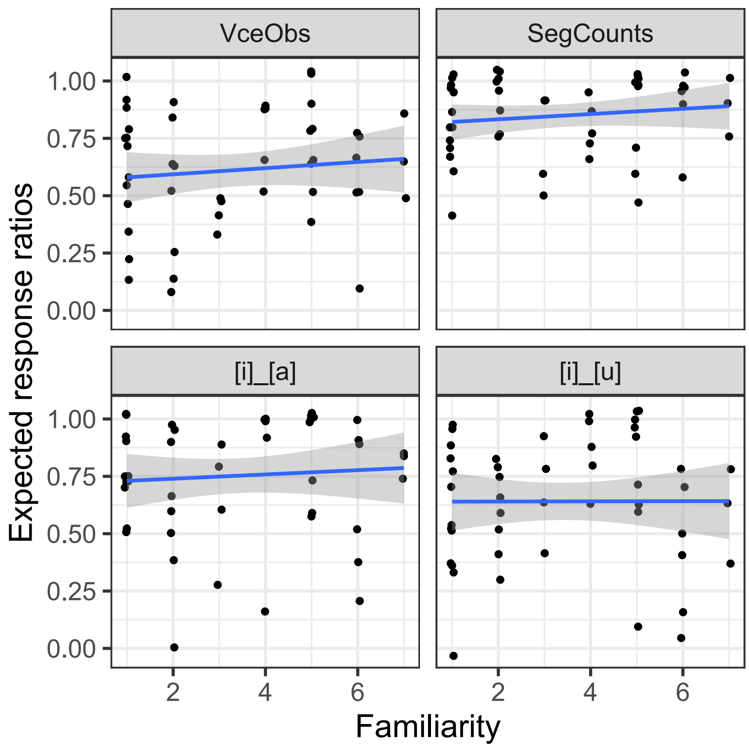

Figure 3: Correlation between familiarity with Pokémon and expected response ratios. The solid lines are linear regression lines. The grey areas represent the 95% confidence intervals.

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 significantly affected the results.

2.4 Discussion

The first condition did not show a significant effect of voiced obstruents, contrary to the previous finding (Kawahara & Kumagai 2019a). The fact that we did not observe a significant effect may be

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

explainable in terms of the difference in how the laryngeal contrast is implemented between English and Japanese. In word-initial positions, the “voiced stops” in English do not involve clear vocal fold vibration (Keating 1984; Kingston & Diehl 1994; Lisker 1986). We expected that we may nevertheless observe an effect of voiced obstruents, since even word-initially, “voiced stops” 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 stops should be judged to be larger than voiceless stops. 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-related 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; Stevens & Blumstein 1981). 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 result of 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 Jespersen (1922) and Sapir (1929) argue, this sound symbolic effect may have its roots 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; Kawahara et al. 2018a; 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-

[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.

related sound symbolism, because both [u] and [i] are high/closed vowels. At the very minimum, this result shows that vowels' front/back distinction is relevant to sound symbolism in English. 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 the existing Pokémon names.

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*). They were both disyllabic.

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 labial consonants 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 labial consonants in the name are found to be associated with smaller size (Shih et al. 2018). 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 labial consonants are observed outside the Pokémon universe as well. Kumagai & Kawahara (2020), for example, showed that Japanese speakers prefer to use labial consonants 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 labial consonants are acquired at an early stage of language acquisition (see Ota 2015 for actual acquisition 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 labial consonants 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,

[12]To the best of our knowledge, no studies directly explored the sound symbolic connections between labial consonants and images of size in English, but some studies have explored other sound symbolic values of labial consonants. D'Onofrio (2014), for example, found that [b] and [u], particularly its combination, tend to be associated with round shapes. Hosokawa et al. (2018) found that labial consonants appear less frequently in villain's names than in non-villains' names in the corpus of English Disney character names.

[13]As an anonymous reviewer pointed out, labial consonants 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 we can see 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.

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 took 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.

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 averages 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 significantly 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 coronal consonants, rather than labial consonants, with post-evolution levels ($z = 5.26, p < .001$). The fourth condition showed no significant deviation from chance level ($z = 0.21, n.s.$).

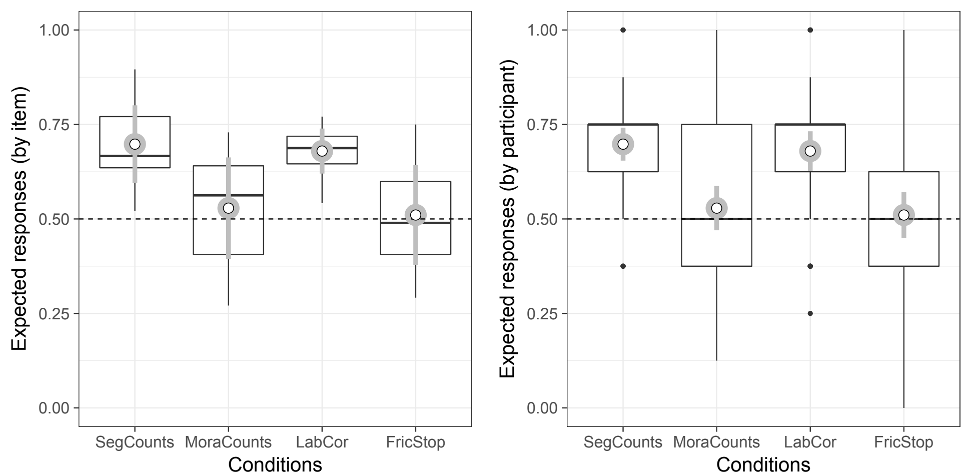

Figure 4: Expected response ratios for each condition by item and by participant (Experiment 2).

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 the 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.

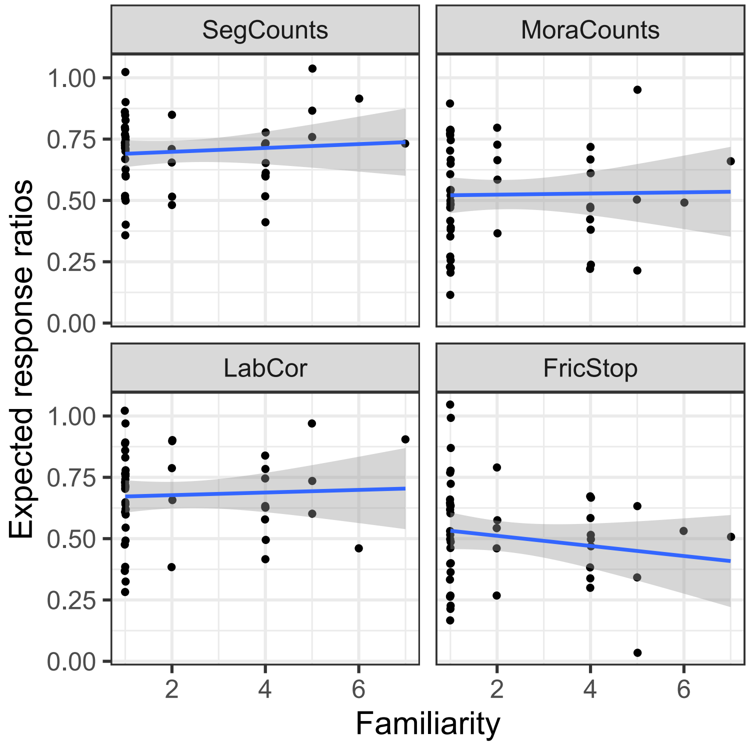

Figure 5: Correlation between familiarity with Pokémon and expected response ratios (Experiment 2).

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 to be symbolically "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 English Pokémon characters (see also Shih & Rudin 2019).[14]

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 generally 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 coronal consonants with

[14]This is not to preclude the possibility that English speakers can use other measures such as mora/syllable counts when they deploy the iconicity of quantity to express sound symbolic meanings in other contexts.

post-evolution characters, as predicted by Shih et al. (2018), and associate labial consonants with pre-evolution characters.[15] While there is an accumulating body of evidence that labial consonants bear particular sound symbolic values for Japanese speakers (Kawahara & Kumagai 2019b; Kumagai & Kawahara 2020), not much was known about the speakers of other languages. The current result shows that English speakers too, like Japanese speakers, may associate labial consonants with images of smallness, as compared to coronal consonants at least. This sound symbolic association holds arguably because labial consonants 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 on the right track, then we expect this sound symbolic effect to hold in other languages, which can be tested in future studies.

To the extent that labial consonants can be associated with images of smallness, it shows that the Frequency Code Hypothesis does not dictate all sound symbolic patterns. This is because labial consonants 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 1981). 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" number was *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 (Exper-

[15]When we designed the experiment, we assumed that [w] is a labial glide and [j] is a coronal glide (following, for example, 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 (Keating 1988; Nevins & Chitoran 2008). As a post-hoc examination, therefore, we 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 effect in the expected direction.

iment 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; labial consonants 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; palatal consonants, which are 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 address 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 coronal consonants are more likely to be associated with post-evolution characters than names with labial consonants (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 sound symbolic 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 holds very robustly 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 when 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 size-related sound symbolic effect of labial consonants, as compared to coronal consonants, 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 size-related sound symbolic value of labial consonants, and invites further studies targeting other languages.

Failing to find a robust effect of voiced stops may tell us something important as well; the effect of voiced stops 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; Keating 1984; Kingston & Diehl 1994). 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 labial consonants). 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 in future research therefore seem to be: what are other principles, and how do they interact with the Frequency Code? The findings from the current experiments 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 many opportunities for future work in sound symbolism.

References

Akita, Kimi. 2015. Sound symbolism. In Jan-Ola Östman & Jef Verschueren (eds.), *Handbook of pragmatics, installment 2015*, Amsterdam and Philadelphia: John Benjamins.

Akita, Kimi & Mark Dingemanse. 2019. Ideophones (mimetics, expressives). In Mark Aronoff (ed.), *Oxford research encyclopedia of linguistics*, Oxford: Oxford University Press.

Alderete, John & Alexei Kochetov. 2017. Integrating sound symbolism with core grammar: The case of expressive palatalization. *Language* 93. 731–766.

Bankieris, Kaitlyn & Julia Simner. 2015. What is the link between synaesthesia and sound symbolism? *Cognition* 136. 186–195.

Barr, Dale J. 2013. Random effects structure for testing interactions in linear mixed-effects models. *Frontiers in Psychology* 4. 328.

Barr, Dale J., Roger Levy, Christoph Scheepers & Harry J. Tily. 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language* 68. 255–278.

Berlin, Brent. 2006. The first congress of ethonozoological nomenclature. *Journal of Royal Anthropological Institution* 12. 23–44.

Blasi, Damián, Søren Wichman, Harald Hammarström, Peter F. Stadler & Morten H. Christianson. 2016. Sound-meaning association biases evidenced across thousands of languages. *Proceedings of National Academy of Sciences* 113(39). 10818–10823.

Brown, Roger & Marquerite Ford. 1961. Address in American English. *Journal of Abnormal and Social Psychology* 62. 375–385.

Cassidy, Kimberly Wright, Michael H. Kelly & Lee'at J. Sharoni. 1999. Inferring gender from name phonology. *Journal of Experimental Psychology: General* 128. 362–381.

Cho, Taehong & Peter Ladefoged. 1999. Variation and universals in VOT: Evidence from 18 languages. *Journal of Phonetics* 27(2). 207–229.

Chodroff, Eleanor & Colin Wilson. 2014. Burst spectrum as a cue for the stop voicing contrast in American English. *Journal of the Acoustical Society of America* 136(5). 2762–2772.

Clements, Nick & Elizabeth Hume. 1995. The internal organization of speech sounds. In John A. Goldsmith (ed.), *The handbook of phonological theory*, 245–306. Cambridge and Oxford: Blackwell.

Coulter, S. Keith & Robin A. Coulter. 2010. Small sounds, big deals: Phonetic symbolism effects in pricing. *Journal of Consumer Research* 37(2). 315–328.

Cuskley, Christine & Simon Kirby. 2013. Synesthesia, cross-modality, and language evolution. In Julia Simner & Edward Hubbard (eds.), *Oxford handbook of synesthesia*, Oxford: Oxford University Press.

Cuskley, Christine, Julia Simner & Simon Kirby. 2017. Phonological and orthographic influences in the bouba-kiki effect. *Psychologiacl Research* 81(1). 119–130.

Cutler, Anne, James McQueen & Ken Robinson. 1990. Elizabeth and John: Sound patterns of men's and women's names. *Journal of Linguistics* 26. 471–482.

Daland, Robert, Bruce Hayes, James White, Marc Garellek, Andrea Davis & Ingrid Norrmann. 2011. Explaining sonority projection effects. *Phonology* 28(2). 197–234.

Diffloth, Gérard. 1994. i: *big*, a: *small*. In Leane Hinton, Johanna Nichols & John J. Ohala (eds.), *Sound symbolism*, 107–114. Cambridge: Cambridge University Press.

Dingemanse, Mark. 2015. Ideophones and reduplication: Depiction, description, and the interpretation of repeated talk in discourse. *Studies in Language* 39(4). 946–970.

Dingemanse, Mark. 2018. Redrawing the margins of language: Lessons from research on ideophones. *Glossa* 3(1). 4, doi:org/10.5334/gjgl.444.

Dingemanse, Mark, Damián E. Blasi, Gary Lupyan, Morten H. Christiansen & Padraic Monaghan. 2015. Arbitrariness, iconicity and systematicity in language. *Trends in Cognitive Sciences* 19(10). 603–615.

D'Onofrio, Annette. 2014. Phonetic detail and dimensionality in sound-shape correspondences: Refining the *bouba-kiki* paradigm. *Language and Speech* 57(3). 367–393.

Firth, J. R. 1930. *The tongues of men & speech*. London: Oxford Mission Press.

Fort, Mathilde, Alexa Weiβ, Alexander Martin & Sharon Peperkamp. 2013. Looking for the bouba-kiki effect in prelexical infants. *Proceedings of the International Conference on Aditory-Visual Speech Processing* 71–76.

Fuchs, Susanne, Egor Savin, Stephanie Solt, Cornelia Ebert & Manfred Krifca. 2019. Antonym adjective pairs and prosodic iconicity: Evidence from letter replications in an English blogger corpus. *Linguistic Vanguard* 1–15.

Godoy, Mahayana C., Neemias Silva de Souza Filho, Juliana G. Marques de Souza, Hális Alves & Shigeto Kawahara. 2019. Gotta name'em all: An experimental study on the sound symbolism of Pokémon names in Brazilian Portuguese. *Journal of Psycholinguistic Research* .

Haiman, John. 1980. The iconicity of grammar: Isomorphism and motivation. *Language* 56(3). 515–540.

Halle, Morris. 2005. Palatalization/velar softening: What it is and what it tells us about the nature of language. *Linguistic Inquiry* 36(1). 23–41.

Hamano, Shoko. 1998. *The sound-symbolic system of Japanese*. Stanford: CSLI Publications.

Hawkins, John & Anne Cutler. 1988. Psycholinguistic factors in morphological asymmetry. In J. A. Hawkins (ed.), *Explaining language universals.*, 280–317. Oxford: Basil Blackwell.

Hinton, Leane, Johanna Nichols & John J. Ohala. 1994. Introduction: Sound-symbolic processes. In Leane Hinton, Johanna Nichols & John J. Ohala (eds.), *Sound symbolism*, 1–12. Cambridge:

Cambridge University press.

Hockett, Charles. 1959. Animal “languages” and human language. *Human Biology* 31. 32–39.

Hosokawa, Yuta, Naho Atsumi, Ryoko Uno & Kazuko Shinohara. 2018. Evil or not? Sound symbolism in Pokémon and Disney character names. Talk presented at the 1st international conference on Pokémonastics.

Imai, Mutsumi & Sotaro Kita. 2014. The sound symbolism bootstrapping hypothesis for language acquisition and language evolution. *Philosophical Transactions of the Royal Society B: Biological Sciences* 369(1651).

Imai, Mutsumi, Sotaro Kita, Miho Nagumo & Hiroyuki Okada. 2008. Sound symbolism facilitates early verb learning. *Cognition* 109. 54–65.

International Phonetic Association. 1999. *Handbook of the International Phonetics Association*. Cambridge: Cambridge University Press.

Ito, Junko. 1989. A prosodic theory of epenthesis. *Natural Language and Linguistic Theory* 7. 217–259.

Iwasaki, Noriko, David P. Vinson & Gabriella Vigiliocco. 2007. What do English speakers know about *gera-gera* and *yota-yota*? A cross-linguistic investigation of mimetic words for laughing and walking. *Japanese Language Education Around the Globe* 17. 53–78.

Jakobson, Roman. 1941. *Child language, aphasia and phonological universals*. The Hague: Mouton. Translated into English by A. Keiler, 1968.

Jespersen, Otto. 1922. Symbolic value of the vowel *i*. In *Linguistica: Selected papers in English, French and German*, vol. 1, 283–303. Copenhagen: Levin and Munksgaard.

Johnson, Keith. 2003. *Acoustic and auditory phonetics: 2nd edition*. Malden and Oxford: Blackwell.

Kantartzis, Katerina, Mutsumi Imai & Sotaro Kita. 2011. Japanese sound symbolism facilitates word learning in English-speaking children. *Cognitive Science* 35(3). 575–586.

Kawahara, Shigeto. 2006. A faithfulness ranking projected from a perceptibility scale: The case of [+voice] in Japanese. *Language* 82(3). 536–574.

Kawahara, Shigeto. to appear. Sound symbolism and theoretical phonology. *Language and Linguistic Compass* .

Kawahara, Shigeto & Aaron Braver. 2014. Durational properties of emphatically-lengthened consonants in Japanese. *Journal of International Phonetic Association* 44(3). 237–260.

Kawahara, Shigeto, Miwa Isobe, Yukino Kobayashi, Tomoko Monou & Reiko Okabe. 2018a. Acquisition of sound symbolic values of vowels and voiced obstruents by Japanese children: Using a Pokémonastics paradigm. *Journal of the Phonetic Society of Japan* 22(2). 122–130.

Kawahara, Shigeto & Gakuji Kumagai. 2019a. Expressing evolution in Pokémon names: Experimental explorations. *Journal of Japanese Linguistics* 35(1). 3–38.

Kawahara, Shigeto & Gakuji Kumagai. 2019b. Inferring Pokémon types using sound symbolism: The effects of voicing and labiality. *Journal of the Phonetic Society of Japan* 23(2). 111–116.

Kawahara, Shigeto, Atsushi Noto & Gakuji Kumagai. 2018b. Sound symbolic patterns in Pokémon names. *Phonetica* 75(3). 219–244.

Kawahara, Shigeto, Kazuko Shinohara & Yumi Uchimoto. 2008. A positional effect in sound symbolism: An experimental study. In *Proceedings of the Japan Cognitive Linguistics Association 8*, 417–427. Tokyo: JCLA.

Keating, Patricia A. 1984. Phonetic and phonological representation of stop consonant voicing. *Language* 60. 286–319.

Keating, Patricia A. 1988. Palatals as complex segments: X-ray evidence. *UCLA Working Papers in Phonetics* 69. 77–91.

Kingston, John & Randy Diehl. 1994. Phonetic knowledge. *Language* 70. 419–454.

Knoeferle, Klemens, Jixing Li, Emanuela Maggioni & Charles Spence. 2017. What drives sound symbolism? Different acoustic cues underlie sound-size and sound-shape mappings. *Scientific Reports* 7.

Kubozono, Haruo. 1999. *Nihongo-no onsei: Gendai gengogaku nyuumon 2 [Japanese phonetics: An introduction to modern linguisitcs 2]*. Tokyo: Iwanami Shoten.

Kumagai, Gakuji & Shigeto Kawahara. 2019. Effects of vowels and voiced obstruents on Pokémon names: Experimental and theoretical approaches [in Japanese]. *Journal of the Linguistic Society of Japan* 155. 65–99.

Kumagai, Gakuji & Shigeto Kawahara. 2020. How abstract is sound symbolism? Labiality and diaper names in Japanese [in Japanese]. *Journal of the Linguistic Society of Japan* 157.

Lehiste, Ilse. 1970. *Suprasegmentals*. Cambridge: MIT Press.

Lisker, Leigh. 1986. "Voicing" in English: A catalog of acoustic features signaling /b/ versus /p/ in trochees. *Language and Speech* 29. 3–11.

Lockwood, Gwilym & Mark Dingemanse. 2015. Iconicity in the lab: A review of behavioral, developmental, and neuroimaging research into sound-symbolism. *Frontiers in Psychology* doi: 10.3389/fpsyg.2015.01246.

MacNeilage, Peter F., Barbara L. Davis & Christine L. Matyear. 1997. Babbling and first words: Phonetic similarities and differences. *Speech Communication* 22(2-3). 269–277.

Marks, Lawrence. 1978. *The unity of the senses: Interrelations among the modalities*. New York: Academic Press.

Mattes, Veronika. 2017. The semantic categories of lexical reduplication. *Studies in Language* 41(4). 813–842.

Maurer, Daphne, Thanujeni Pathman & Catherine J. Mondloch. 2006. The shape of boubas: Sound-shape correspondences in toddlers and adults. *Developmental Science* 9. 316–322.

McCarthy, John J. 1982. Prosodic structure and expletive infixation. *Language* 58. 574–590.

Nevins, Andrew & Ioana Chitoran. 2008. Phonological representations and the variable patterning of glides. *Lingua* 118(12). 1979–1997.

Newman, Stanley. 1933. Further experiments on phonetic symbolism. *American Journal of Psychology* 45. 53–75.

Nooteboom, Sieb. 1981. Lexical retrieval from fragments of spoken words: Beginnings vs. endings. *Journal of Phonetics* 9. 407–424.

Nuckolls, Janis B. 1999. The case for sound symbolism. *Annual Review of Anthropology* 28. 225–252.

Ohala, John J. 1983. The origin of sound patterns in vocal tract constraints. In Peter MacNeilage (ed.), *The production of speech*, 189–216. New York: Springer-Verlag.

Ohala, John J. 1994. The frequency code underlies the sound symbolic use of voice pitch. In Leane Hinton, Johanna Nichols & John J. Ohala (eds.), *Sound symbolism*, 325–347. Cambridge: Cambridge University Press.

Ota, Mitsuhiko. 2015. L1 phonology: Phonological development. In Haruo Kubozono (ed.), *The handbook of Japanese language and linguistics: Phonetics and phonology*, 681–717. Berlin: Mouton.

Peña, Marcela, Jacques Mehler & Marina Nespor. 2011. The role of audiovisual processing in early conceptual development. *Psychological Science* 22(11). 1419–1421.

Perniss, Pamela, Robin L. Thompson & Gabriella Vigiliocco. 2010. Iconicity as a general property of language: Evidence from spoken and signed languages. *Frontiers in Psychology* doi:10.3389/fpsyg.2010.00227.

Proctor, Michael I., Christine H. Shadle & Khalil Iskarous. 2010. Pharyngeal articulation differences in voiced and voiceless fricatives. *Journal of the Acoustical Society of America* 127(3). 1507–1518.

Ramachandran, Vilayanur S. & Edward M. Hubbard. 2001. Synesthesia–a window into perception, thought, and language. *Journal of Consciousness Studies* 8(12). 3–34.

Sapir, Edward. 1929. A study in phonetic symbolism. *Journal of Experimental Psychology* 12. 225–239.

Saussure, Ferdinand de. 1916. *Cours de linguistique générale*. Paris: Payot.

Schmidtke, David S., Markus Conrad & Arthur M. Jacobs. 2014. Phonological iconicity. *Frontiers in Psychology* 5(80). doi: 10.3389/fpsyg.2014.00080.

Shih, Stephanie S., Jordan Ackerman, Noah Hermalin, Sharon Inkelas, Hayeun Jang, Jessica Johnson, Darya Kavitskaya, Shigeto Kawahara, Miran Oh, Rebecca L Starr & Alan Yu. 2019. Cross-linguistic and language-specific sound symbolism: Pokémonastics. Ms. University of Southern California, University of California, Merced, University of California, Berkeley, Keio University, National University of Singapore and University of Chicago.

Shih, Stephanie S., Jordan Ackerman, Noah Hermalin, Sharon Inkelas & Darya Kavitskaya. 2018. Pokémonikers: A study of sound symbolism and Pokémon names. *Proceedings of LSA* 2018.

Shih, Stephanie S & Deniz Rudin. 2019. On sound symbolism in baseball player names. Ms. University of Southern California.

Shinohara, Kazuko & Shigeto Kawahara. 2016. A cross-linguistic study of sound symbolism: The images of size. In *Proceedings of the Thirty Sixth Annual Meeting of the Berkeley Linguistics Society.*, 396–410. Berkeley: Berkeley Linguistics Society.

Sidhu, David & Penny M. Pexman. 2015. What's in a name? Sound symbolism and gender in first names. *PLoS ONE* 10(5). e0126809, doi:10.1371/journal.pone.0126809.

Sidhu, David & Penny M. Pexman. 2018. Five mechanisms of sound symbolic association. *Psychonomic Bulletin & Review* 25(5). 1619–1643.

Sidhu, David & Penny M. Pexman. 2019. The sound symbolism of names. *Current Directions in Psychological Science* 1–5.

Sidhu, David M., Kristen Deschamps, Joshua S. Bourdage & Penny M. Pexman. 2019. Does the name say it all? Investigating phoneme-personality sound symbolism in first names. *Journal of Experimental Psychology: General* 148(9). 1595–1614.

Sidorov, V. N., Penny M. Pexman & Jean Saint-Aubin. 2016. From the Bob-Kirk effect to the Benoit-Éric effect: Testing the mechanism of name sound symbolism in two languages. *Acta Psychologica* 169. 88–99.

Slater, Anne Saxon & Saul Feinman. 1985. Gender and the phonology of North American first names. *Sex Roles* 13. 429–440.

Spence, Charles. 2011. Crossmodal correspondences: A tutorial review. *Attention, Perception & Psychophysics* 73(4). 971–995.

Stevens, Kenneth. 1998. *Acoustic phonetics*. Cambridge, MA: MIT Press.

Stevens, Kenneth & Sheila Blumstein. 1981. The search for invariant acoustic correlates of phonetic features. In Peter Eimas & Joanne D. Miller (eds.), *Perspectives on the study of speech*, 1–38. New Jersey: Earlbaum.

Styles, Suzy J. & Lauren Gawne. 2017. When does maluma/takete fail? Two key failures and a meta-analysis suggest that phonology and phonotactics matter. *i-Perception* 1–17.

Sullivan, Lisa. 2018. *Phonology of gender in French and English names*: University of Toronto Master's thesis.

Suzuki, Michinori. 2017. The sound symbolic patterns in Pokémon move names. Talk presented at

Asia Junior Linguistics (AJL), International Christian University.

Svantesson, Jan-Olof. 2017. Sound symbolism: The role of word sound in meaning. *WIRE Cog Sci* e01441.

Whalen, Douglas H & Andrea G. Levitt. 1995. The universality of intrinsic F0 of vowels. *Journal of Phonetics* 23. 349–366.

Whissell, Cynthia. 2001. Cues to referent gender in randomly constructed names. *Perceptual and Motor Skills* 93. 856–858.

Wong, Kristen Wing Yan & Yoonjung Kang. 2019. Sound symbolism of gender in Cantonese first names. *Proceedings of ICPhS* .

Wright, Saundra, Jennifer Hay & Bent Tessa. 2005. Ladies first? phonology, frequency, and the naming conspiracy. *Linguistics* 43(3). 531–561.