Exploring sound symbolic knowledge of English speakers using Pokémon character names

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Abstract

This paper is a contribution to the studies of sound symbolism, systematic relationships between sounds and meanings. 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 participants tend to associate post-evolution characters with (1) names containing voiced obstruents ([b, d, ɡ, z]), (2) names with more segments, (3) names containing [a], (4) names containing [u], and (5) names containing coronal consonants. Overall, the current results suggest that phonological properties of names non-trivially affect the naming patterns of new creatures, implying that the relationships between sounds and meanings are not as arbitrary as modern linguistic theories generally assume.

1 General introduction

Modern thinking about languages generally assumes that the relationships between sounds and meanings are arbitrary. That is to say that there is no inherent relationship between the sequence of sounds /kæt/ and the animal that this sound sequence refers to. This thesis was articulated as the first principle of natural languages by Saussure (1916), and was considered one of the design features of human languages that distinguishes them from other animals' communication systems by Hockett (1955). This work has had determining influences on those current linguistic theories for which sounds and meanings generally do not have systematic associations. However, an increasing number of studies have identified systematic correspondence between sounds and meanings, patterns which are often referred to as "sound symbolism" (see Dingemanse et al. 2015;

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Hinton et al. 2006; Lockwood & Dingemanse 2015; Sidhu & Pexman 2017; Spence 2011 for recent reviews). 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; Ultan 1978). A recent extensive cross-linguistic study by Blasi et al. (2016) shows that [i] is used in words representing "small" in many languages. While there is no doubt that language is a system that is capable of associating meanings with sounds in arbitrary ways, there are nevertheless stochastic—statistical and non-deterministic—tendencies for certain sounds to be associated with certain meanings. In recent years, the research on sound symbolism has been becoming increasingly active in phonetic and psychological studies.

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 characterized by different phonological features in English (Brown & Ford 1961; Cassidy et al. 1999; Cutler et al. 1990; Slater & Feinman 1985; Tessier 2010; Whissell 2001; Wright et al. 2005), some of which are sound symbolic; e.g. male names are more likely to contain obstruents (oral stops, fricatives, and affricates) than female names, whereas female names are more likely to contain sonorants (nasals, liquids, glides) than male names. These generalizations are arguably rooted in a sound-symbolic relationship in which obstruents are associated with images of "angularity," "inaccessibleness" and/or "unfriendliness," whereas sonorants are associated with images of "roundness," "accessibleness" and/or "friendliness" (Kawahara et al. 2015; Köhler 1929; Lindauer 1990; Nielsen & Rendall 2011, 2013; Shinohara & Kawahara 2013).

Within this theoretical context, a series of recent studies have used the names of Pokémon characters to explore the nature of sound symbolism in natural languages (Kawahara et al. 2018a,b; Kawahara & Kumagai 2019; Kumagai & Kawahara to appear; Shih et al. 2018). 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. 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 Japanese Pokémon names, voiced obstruents ([b, d, g, z])[1] are shown to be associated with Pokémon characters that are

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[1]Obstruents are a class of sounds in which the air is obstructed in the oral cavity so much that spontaneous vocal fold vibration becomes difficult to sustain (Chomsky & Halle 1968; Shinohara & Kawahara 2016). Typical obstruents include [p, t, k, s, f, b, d, g, v, z]. Voiced obstruents are produced with vocal fold vibration along with obstruction

larger, heavier, stronger and more evolved (Kawahara et al. 2018b). Names with higher mora counts[2] were also shown to be 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 (Kawahara et al. 2018a; Kawahara & Kumagai 2019; Kumagai & Kawahara to appear).

The study by Shih et al. (2018) on the existing English Pokémon characters' names has identified various sound symbolic patterns as well. Their findings are summarized in (1). This paper aims to examine the productivity of these sound symbolic patterns found in the existing English Pokémon names.

(1)   Findings of Shih et al. (2018): 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.

This paper reports on two experiments that test the productivity of these sound symbolic patterns identified by Shih et al. (2018). The two experiments reported below also test whether other sound symbolic patterns reported in the literature apply in the context of naming new Pokémon characters.

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 characters.

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in the oral cavity, which requires some non-trivial articulatory maneuvers (Ohala 1983)—these articulatory maneuvers, which result in the expansion of the oral cavity (Proctor et al. 2010), demonstrably lead to images of largeness (Kawahara 2017; Shinohara & Kawahara 2016).

[2]Moras are psycholinguistically the most salient counting units in Japanese (Kubozono 1999a; Otake et al. 1993; Labrune 2012): a short vowel counts as one mora, as does the first half of a long consonant, the second half of a long vowel, and the coda nasal. 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, the crucial point is the simple, uncontroversial assumption that vowels increase the mora count.

b.   Names with higher segment counts are associated with larger Pokémon characters.

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

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

The first hypothesis was motivated by the observation that in Japanese and English, voiced obstruents are associated with images of largeness. This observation is well-known and well-studied in Japanese (Hamano 1986; Kawahara 2015, 2017; Kawahara et al. 2008; Kubozono 1999b; Shinohara & Kawahara 2016; Suzuki 1962); although it is probably less well-known, this sound symbolic association is known to hold in English as well (Newman 1933; Shinohara & Kawahara 2016). In the context of Pokémon names, the study by Shih et al. (2018) found a positive correlation between the number of voiced obstruents contained in the English Pokémon names and the weight of the Pokémon characters. Kawahara & Kumagai (2019) report one experiment in which English speakers were asked to compare pairs of two nonce names, like *mureya* and *zuhemi*, and choose which nonce name better matches a post-evolution character. Their results show that English speakers tend to associate names containing a voiced obstruent (e.g. *zuhemi*) with post-evolution characters. However, the stimuli used in their study were Japanese-sounding words, consisting of three light syllables. An experiment which uses more English-sounding names was therefore warranted. Experiment 1 takes up this task as one of its aims.

The second hypothesis is related to the role of the "iconicity of quantity" in natural languages (Haiman 1980, 1985), 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"). In the words of Haiman (1980, p. 528), "generally speaking, the positive, comparative, and superlative degrees of adjectives show a gradual increase in the number of phonemes." In the analysis of Japanese Pokémon names, Kawahara et al. (2018b) found that there is a positive correlation between the number of moras on the one hand, and Pokémon size, weight, and evolution levels on the other. Kawahara & Kumagai (2019) demonstrated that this correlation is productive when Japanese speakers are asked to name new Pokémon characters.

Shih et al. (2018) found 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. While Kawahara & Kumagai (2019) showed that English speakers tend to associate longer names with post-evolution characters, Kawahara & Kumagai (2019) only manipulated mora counts, not segment counts. The current experiment thus tests the productivity of the sound symbolic effect of segment counts for English speakers.

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—that low vowels tend to be associated with images that are larger than high, front vowels—is very well-known in the literature on sound symbolism (e.g. Blasi et al. 2016; Berlin 2006; Coulter & Coulter 2010; Jespersen 1922; Newman 1933; Sapir 1929; Shinohara & Kawahara 2016; Ultan 1978), and is also observed in the existing English Pokémon names. However, sound symbolic effects of vowel quality differences have not been tested experimentally using Pokémon names, a gap this paper intends to fill.

The third and fourth hypotheses are motivated by the Frequency Code Hypothesis proposed by Ohala (1984, 1994). This hypothesis suggests that sounds with low frequency energy are generally associated with something large, because this is what physics tells us—larger objects, when they vibrate, emit lower frequency sounds. The intrinsic F0 of [a] is lower than that of [i] (Whalen & Levitt 1995), and thus this vowel projects 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). Thus, this sound is associates with images of smallness (Jespersen 1922). Berlin (2006) argues, building on Ohala's theory, that front vowels are generally associated with images of smallness compared to back vowels in many different languages, because front vowels have higher F2. These proposals predict that [u] should be better suited to represent characters larger than [i], when English speakers name new Pokémon characters.

2.2 Method

2.2.1 Stimuli

Eight items were created to test each of the hypotheses in (2). The whole list of stimulus 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. More specifically, a long name has two extra consonants compared to the corresponding short name (e.g. *Kooten* vs. *Skoolten*). Since what we are interested in is 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 are 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). 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. Tanea	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. Although Shih et al's (2018) study revealed correlations between particular sounds and several parameters such as weight and strength, the main target of the current experiment was size (as expressed via evolution), 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.[3] These pictures are those that have been used in previous Pokémon naming experiments as well (Kawahara et al. 2018a; Kawahara & Kumagai 2019; Kumagai & Kawahara to appear). 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 two nonce names (those in Table 1). The participants were asked to choose which name suited the pre-evolution character

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[3]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`.

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.

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. After the main trials, the participants were asked how familiar they are with Pokémon using a 7-point Lickert scale.

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 violin plots of the expected response ratios for each condition by item (left) and by participant (right). In violin plots, probability distributions are represented by the widths. Black dots represent the jittered average response for each item (left) and for each participant (right). White circles represent the grand averages, and thick grey error bars around the means represent the 95% confidence intervals.
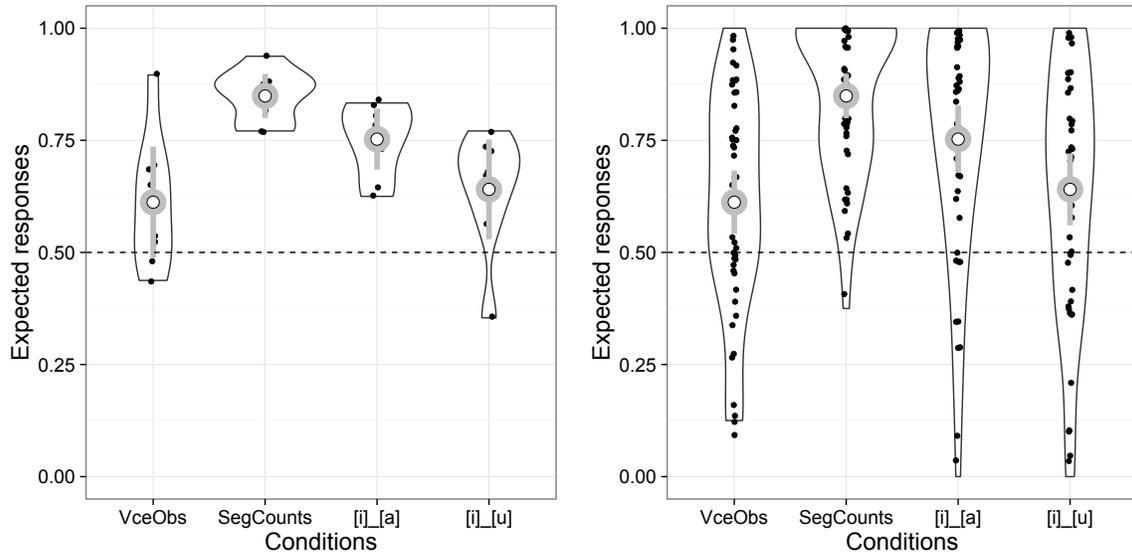
Figure 2: Expected response ratios for each condition by item (left) and by participant (right). The grand means are shown with white circles. Grey thick error bars around the grand means represent the 95% confidence intervals. Experiment 1.

The first condition, which examined the effects of voiced obstruents, showed response distributions above the 0.5 chance level (the grand mean ratio = 0.61, by-participant analysis, $t(47) = 3.19, p < .01$).[4] The second condition, which tested the effects of segment counts, showed very high expected response percentages (the grand mean ratio = 0.85, $t(47) = 14.14, p < .001$). The third condition, which compared [a] and [i], also showed skews toward associating [a] with post-evolution characters (the grand mean ration= 0.75, $t(47) = 6.77, p < .001$). The fourth condition showed a tendency toward associating [u] with post-evolution characters (the grand mean ration= 0.64, $t(47) = 3.53, p < .001$). In short, all of the four conditions showed results that are expected from the sound symbolic principles reviewed at the beginning of this section.

One question that arises is whether these sound symbolic patterns arise from exposure to existing Pokémon names, or whether the participants possess knowledge of sound symbolism independently of the exposure to Pokémon. If the former, there should be a positive correlation between their familiarity with Pokémon and expected response ratios; 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 shows the correlation between familiarity with Pokémon and expected response ratios for each condition.

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[4]Since there are only eight items per condition, statistical significance was accessed via by-participant analyses.
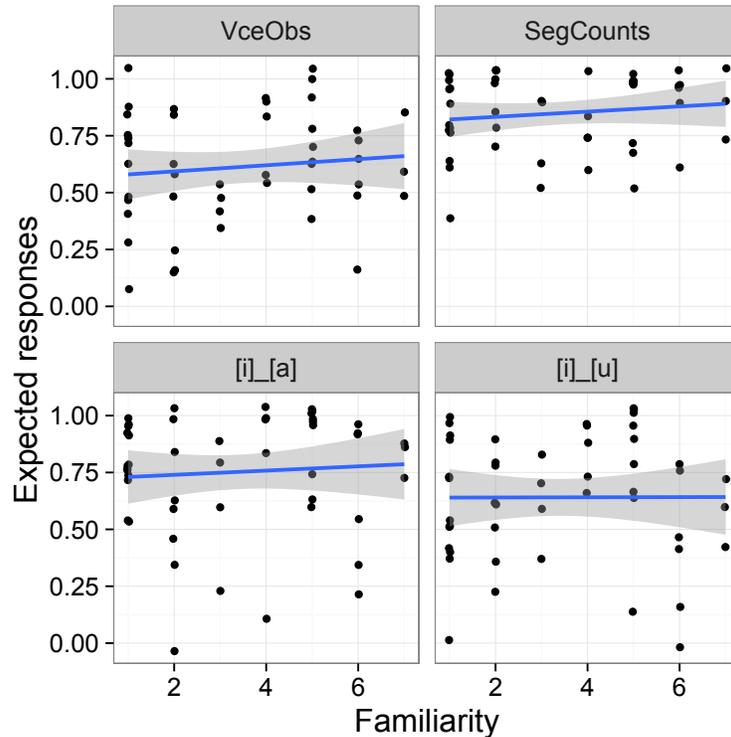
Figure 3: Correlation between familiarity with Pokémon and expected response ratios in Experiment 1. The solid lines are linear regression lines. The grey areas represent the 95% confidence intervals.

None of the conditions shows a positive correlation between familiarity and expected response ratios ($r = 0.11, n.s.$, $r = 0.14, n.s.$, $r = 0.07, n.s.$, and $r = 0.00, n.s.$). Therefore, exposure to existing Pokémon names does not seem to have affected the results. Instead, it seems more natural to conclude that English speakers generally possess knowledge of sound symbolism in (2), and are able to apply that knowledge when they name new Pokémon characters.

2.4 Discussion

The first condition shows that English speakers generally find names with voiced obstruents to be more suitable for post-evolution characters. This result is in line with previous findings that English speakers find nonce words with voiced obstruents to be larger than nonce words with voiceless obstruents (Newman 1933; Shinohara & Kawahara 2016). Ohala's Frequency Code Hypothesis (1984; 1994) may offer an explanation of this general sound symbolic pattern. Voiced obstruents show lower energy (in particular, F0 and F1) in their surrounding vowels than voiceless obstruents (Kingston & Diehl 1994, 1995); voiced obstruents are also often characterized with voicing during constriction, which acoustically manifests itself as low frequency energy (a.k.a. "a voice bar")

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(Stevens & Blumstein 1981). A recent study by Chodroff & Wilson (2014) shows in addition that burst spectra of voiced stops have lower frequencies than those of voiceless obstruents. In short, voiced obstruents are characterized by general low frequency energy (Kingston & Diehl 1995; Kingston et al. 2008), which may result in images of largeness, according to the Frequency Code Hypothesis.

Alternatively, the vocal tract expansion that is necessitated by the aerodynamic conditions on maintaining vocal fold vibration with obstruent closure (e.g. Ohala 1983; Proctor et al. 2010) may result in images of largeness (Kawahara 2017; Shinohara & Kawahara 2016). To the best of our knowledge, as yet we have no empirical evidence to tease apart the acoustics vs. articulatory hypotheses. (In Experiment 2, we will observe that an acoustics account does not explain all the sound symbolic principles.)

The second condition shows that there are robust effects of "iconicity of quantity" in which longer words express something large (Haiman 1980, 1985)—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 in the minds of native speakers of English.

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 much lower F0 and F2 compared to [i].

The fourth condition shows that the degree of oral aperture cannot explain everything about vowel-related sound symbolism, because both [u] and [i] are high, closed vowels. At the very minimum, it shows that vowels' front/back distinction is relevant to sound symbolism. The direction is as expected from the Frequency Code Hypothesis; [u], being a back vowel, has much lower F2 compared to [i], and hence [i] should be judged smaller than [u], as in the current result.

Looking at the individual data points in Figure 2 in further detail, although all the conditions showed skews in the expected direction, there is a fair amount of between-item and between-participant variation. For instance, in the first condition, which tested the effect of voiced obstruents, four items distribute around chance level, whereas the other four items were well above chance level (see Appendix for the full detail). Looking at the by-participant analysis, there are some individuals who showed expected responses lower than chance level. The second and third conditions show less variation among items—all the items are above chance level. The effects of segment counts and [a] are thus the two most robust sound symbolic effects. It should be noted, however, that even for these two conditions, the by-participant analysis shows that there are some individuals who did not show patterns that are expected from the sound symbolic principles. Gen-

erally, between-speaker variation in terms of sound symbolism is an understudied area, and more research needs to be conducted to fill this gap.

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, which were discussed in other studies of sound symbolism, were also tested in Experiment 2.

(3)   Hypotheses tested in Experiment 2

    a.   The effect of segment counts hold even for a pair of completely morphologically unrelated names.

    b.   Mora/syllable counts affect images of largeness in English, as in Japanese.

    c.   Coronal consonants (e.g. [t, s]) are associated with images of largeness compared to labial consonants (e.g. [p, m]).

    d.   Oral stop consonants (e.g. [p, t]) are associated with images of largeness compared to fricative consonants (e.g. [f, s]).

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, 1985) 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 consonant being an infix. To address this interpretation, the first condition of Experiment 2 paired entirely 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. 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 are more likely to be associated with post-evolution characters, because they have one additional mora/syllable. On the other hand, if segment counts are all that matter, then the response should distribute rather

randomly.

The third condition is 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 associated with smaller size (Shih et al. 2018). Kumagai & Kawahara (2017) showed that Japanese speakers prefer to use labial consonants when they are asked to name new diaper names, in comparison to when they are asked to name new cosmetic brand names. They hypothesize that since labial consonants 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. 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. *Taamair*). 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 (Ohala 1984, 1994) predicts that fricatives imply things that are small. 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.

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

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

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 violin plots of expected response ratios for each condition by item (left) and by participant (right). The first condition, which examined the effects of segment counts, show response distributions above chance level (the mean = 69.8%, $t(46) = 9.04, p < .001$). The second condition, which fixed the segment counts and varied mora counts, did not show substantial deviation from chance level (the mean = 52.9%, $t(46) = 0.82, n.s.$). The third condition showed skews toward associating coronal consonants, rather than labial consonants, with post-evolution levels (the mean = 68.0%, $t(46) = 6.71, p < .001$). The fourth condition showed no deviations from chance level (the mean = 50.8%, $t(46) = 0.26, n.s.$).
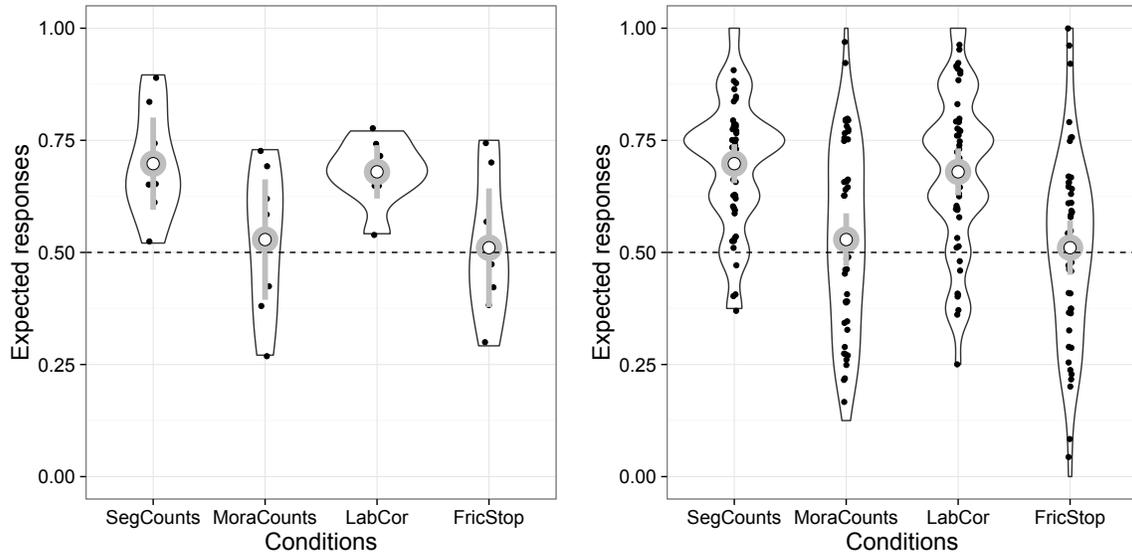
Figure 4: Expected response ratios for each condition by item (left) and by participant (right). The grand means are shown with white circles. Grey error bars around the grand means represent the 95% confidence intervals. Experiment 2.

Looking at the by-participant distributions for the second and fourth conditions, the distributions seem to be fairly random, centering around chance level: some speakers chose one type of stimuli to be better suited for post-evolution characters, while other speakers chose the other type of stimuli. These results imply that for these two conditions, there is no sound symbolic principle that is shared by most/all participants in the current experiment. Even for the first and third conditions, there were participants whose scores were around or below chance level. The by-item analyses reveal similar patterns: in the second and fourth conditions, the items are distributed rather randomly around chance level (see Appendix for full detail). Even for the first and third conditions, there are items that are barely above chance level. These observations show that, as observed in the previous literature and Experiment 1, sound symbolic principles exert only stochastic influences.

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 ($r = 0.09, n.s.$, $r = 0.02, n.s.$, $r = 0.05, n.s.$, and $r = -0.17, n.s.$). 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. In other words, English speakers seem to possess knowledge of the sound symbolism related to the iconocity of quantity and labial consonants, and apply that knowledge when they choose names for new Pokémon characters.

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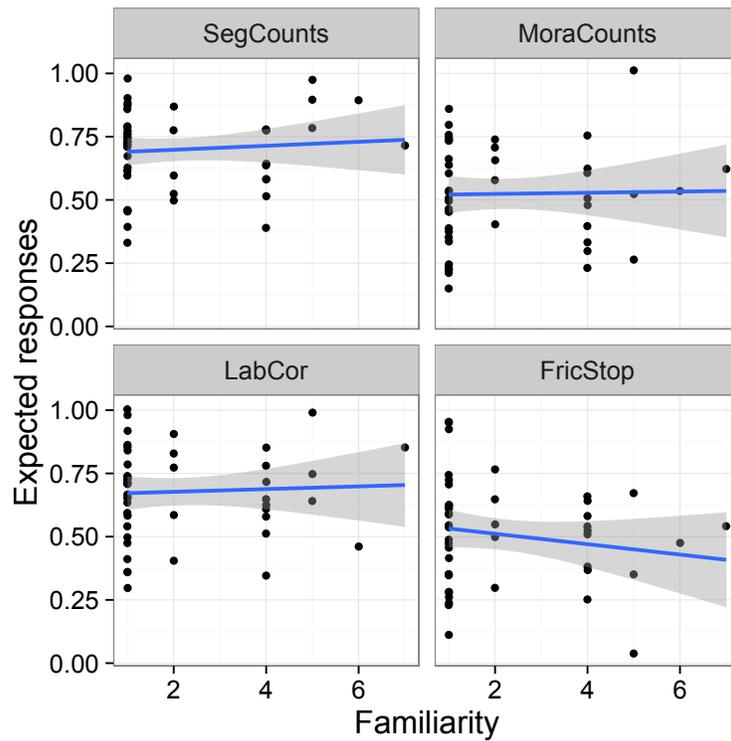
Figure 5: Correlation between familiarity with Pokémon and expected response ratios in Experiment 2. The grey areas represent the 95% confidence intervals.

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.

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 impact images of largeness for English speakers. This result further supports Shih's (2018) finding that segment count is a better predictor than mora counts for existing Pokémon characters in English. This finding points to an interesting difference between Japanese and English. In Japanese, one cannot generally increase segment count without increasing mora count, because consonants do not stand alone without a vowel (Ito 1989); the only exception would be to add a coda nasal consonant, but this strategy too would increase the mora count.[5] 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 post-evolution characters, and associate labial consonants with pre-evolution characters. While sound symbolic values of labial consonants for size-related sound symbolism have only been tested for Japanese speakers so far,[6] it may be that English speakers too associate labial consonants with images of smallness, arguably because labial consonants are prototypically those sounds that are acquired early in language acquisition, frequently observed both in babbling and early speech (Jakobson 1941; MacNeilage et al. 1997).

To the extent that labial consonants can be associated with images of smallness, 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; 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 (see Sidhu & Pexman 2017 for extended discussion on this point).

The fourth condition showed that fricatives are not necessarily associated with something lighter than stops, contra Coulter & Coulter (2010). It may be that while fricatives have high frequency energy, since voiceless stops are characterized by silence, they can lead to images of

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[5]One limited environment in which this may be possible is to add an onset consonant to vowel-initial syllables. However, a vowel-initial syllable is often accompanied by a glottal stop, so adding a consonant may not increase segment counts after all. For this reason, testing the effects of segment counts, apart from those of mora counts, is very difficult.

[6]D'Onofrio (2014) shows that the combination of [b] and [u] yields a rather strong image of roundedness.

smallness as well. One comparison that can be conducted in future research is fricatives vs. nasals, the latter of which have clear low frequency energy during constriction (see Berlin 2006 for a proposal that nasal consonants can imply something large, due to their low frequency energy).

4   Conclusion

To conclude, the current studies have found the following sound symbolic patterns to be active among English speakers (at least, among most of them):

(4)

a.   Names with voiced obstruents are more likely to be associated with post-evolution characters.

b.   Names with higher segment counts are more likely to be associated with post-evolution characters.

c.   Names with [a] in initial syllables are more likely to be associated with post-evolution characters than names with [i] in initial syllables.

d.   Names with [u] in initial syllables are more likely to be associated with post-evolution characters than names with [i] in initial syllables.

e.   Names with coronal consonants are more likely to be associated with post-evolution characters than names with labial consonants.

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

(5)   a.   When mora/syllable counts are manipulated while controlling for segmental counts, no effects of mora/syllable counts were observed.

b.   Names with stops were no more likely to be associated with post-evolution characters than names with fricatives.

In both of the experiments, when there are significant effects of sound symbolism, 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. Instead, we conclude that English speakers have knowledge of sound symbolism, and apply that knowledge when they name new Pokémon characters.

    To conclude, our current case studies can be situated in the research tradition which has shown that names are not chosen randomly, but instead certain types of sounds with particular phonological properties are chosen to capture an aspect of the named object (or person) (Brown & Ford 1961; Cassidy et al. 1999; Cutler et al. 1990; Slater & Feinman 1985; Tessier 2010; Whissell 2001;

Wright et al. 2005). Our conclusion lends further credence to the idea that was already expressed in Plato's *Cratylus*: "Cratylus has been arguing about names; he says that they are natural and not conventional; not a portion of the human voice which men agree to use; but that there is a truth or correctness in them" (383A).

Appendix: Results for each item

Table 3: Results for each item for Experiment 1.

Voiced obstruents	Segment counts	[i] vs. [a]	[i] vs. [u]
Dooben (0.48)	Skoolten (0.77)	Fafgor (0.75)	Toopen (0.73)
Debott (0.69)	Grashren (0.88)	Calpon (0.63)	Gooband (0.35)
Beevair (0.52)	Smostela (0.81)	Patpen (0.65)	Pootgor (0.56)
Bagoise (0.65)	Brulgol (0.88)	Padgor (0.83)	Kootair (0.69)
Dayboom (0.69)	Plortmite (0.77)	Tanea (0.83)	Toockott (0.77)
Doubino (0.44)	Provorl (0.94)	Falgor (0.79)	Doopino (0.63)
Bugol (0.54)	Spootren (0.88)	Mastla (0.81)	Voogott (0.73)
Gobarl (0.9)	Clorgela (0.88)	Balgol (0.73)	Goopigus (0.67)

Table 4: Results for each item for Experiment 2.

Segment counts	Mora counts	Labial vs. coronal	Fricatives vs. stops
Clorgla (0.69)	Akooten (0.27)	Taanair (0.69)	Toopen (0.5)
Spalpni (0.52)	Arashen (0.38)	Todol (0.71)	Tepom (0.75)
Sputren (0.60)	Erugol (0.69)	Tornee (0.77)	Patoil (0.29)
Provorl (0.90)	Upovol (0.42)	Neeten (0.75)	Putol (0.48)
Skulten (0.65)	Elooten (0.63)	Neetock (0.69)	Tietet (0.38)
Plotmit (0.83)	Ukogla (0.58)	Dotol (0.65)	Tietol (0.42)
Brulgol (0.75)	Orepnea (0.54)	Yilyol (0.65)	Potol (0.56)
Grashren (0.65)	Oratodon (0.73)	Yutol (0.54)	Toopal (0.71)

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