Expressing Evolution in Pokemon Names: Experimental Explorations

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Abstract

There has been a growing body of interests in sound symbolic patterns in natural languages, in which some sounds are associated with particular meanings. As a case study, a previous corpus-based research identified some specific sound symbolic relationships in Pokemon naming patterns in Japanese [1]. One of the main findings was that the names of Pokemon characters are more likely to contain voiced obstruents and are longer in terms of mora counts, when they undergo evolution (e.g. *nyoromo* → *nyorobon*; *poppo* → *pijotto*.). The current study reports three experiments that test whether (i) these patterns are productive in the minds of general Japanese speakers (Experiments 1 and 2), and whether (ii) the same tendency would hold with English speakers (Experiment 3). The results show that the effect of mora length was clearly observed both with Japanese speakers and English speakers; the effects of voiced obstruents were observed clearly with Japanese speakers, and less clearly with English speakers. Further analyses show that familiarity with Pokemon may influence their responses, suggesting the possibility that speakers can learn sound-symbolic patterns from a particular set of lexical items (i.e. "the Pokemon lexicon"). Besides its research value, we argue that this general project can be useful for undergraduate phonetics education.

Introduction

Synopsis of the paper

This paper offers an experimental case study of sound symbolism, patterns in which particular sounds are associated with particular meanings ([2] *et seq*). The empirical target is the names of Pokemon characters, following the corpus-based study previously reported by [1]. Pokemon is a game series which has been very popular, especially among young children. Its first series was released in 1996, and continues to be very popular in Japan and across the world. In the Pokemon games, many though not all Pokemon characters undergo evolution, and parameter-wise, they generally get stronger, heavier and larger after evolution (see Fig. 1 for illustration). [1] studied more than 720 Japanese Pokemon names (all the characters in the 1st - 6th generations, excluding some duplicates) from the perspective of sound symbolism, and found that the names of post-evolution Pokemon characters are (i) more likely to include voiced obstruents (/b/, /d/, /g/, /z/) and (ii) are longer in terms of mora counts. In other words, Japanese speakers somehow associate strength/large size/heaviness due to evolution with voiced obstruents and name lengths in Pokemon names. As a next step after this corpus study, this paper reports a series of experiments that explore the productivity of these sound symbolic associations. We also address the question to what extent these sound symbolic patterns are learned from the exposure to actual Pokemon games.

Theoretical background

Let us briefly review the theoretical history of sound symbolism. Whether sounds themselves have meanings or not has been a matter of debate since the time of Plato, and appears in Cratylus [3, 4]. In modern linguistics, the relationship between sounds and meanings was assumed to be arbitrary, which was formulated as the first principle of languages by Saussure [5], also echoed in [6]. Possibly due to the influence of Saussure's thesis, the study of sound symbolism did not flourish in theoretical linguistics very much. In generative frameworks of linguistics, the separation between sounds and meanings is usually assumed—PF (Phonetic Form) and LF (Logical Form) are separate levels of representation, mediated by syntax [7–9], but as far as we know, there is nothing in syntax that directly connects sounds and meanings (except for possible cases like [+focus] feature that connects phonetic prominence and semantic focus: see e.g. [10]).

However, not everybody who works on languages embraces the view that sound-meaning relationships are strictly arbitrary. A pioneering experimental study by Sapir [2] shows that English speakers are more likely to associate *mal* with a bigger object and *mil* with a smaller object. Another classic observation was made by Köhler [11], who showed that a nonce word like *maluma* is more likely to be associated with a round object, whereas a nonce word like *takete* is associated with a spiky object. This observation is now actively studied under the rubric of the *bouba-kiki* effect [12–15]. Many psychologists and cognitive scientists have followed up these observations (e.g. [16–23] among many others; see the following website by Kimi Akita for comprehensive bibliography lists of sound symbolic studies as of December 2010: `https://sites.google.com/site/akitambo/Home/biblio`), and explored the implications of sound symbolism in language acquisition [14, 24–26], language evolution [15, 27], and language universals [28–30]. John Ohala has formulated a general principle—the Frequency Code Hypothesis—which suggests that sounds with higher frequencies are associated with smaller objects, which explains many observed sound symbolic patterns, such as H-tone being associated with the meaning of "smallness" and /i/ being used in diminutive affixes in many languages because of its high F2 [31–33]. [34] extended this hypothesis to explain why many languages use rising intonation for interrogative sentences. See [35], [36] and [37] for more extended recent reviews. In short, while languages can associate meanings and sounds in an arbitrary way, as Saussure [5] formulated, there can be stochastic tendencies to connect sounds and meanings in systematic ways as well. Studying sound symbolism is important for linguistics, to the extent that it may have to do with the language acquisition and evolution of human languages. Sound symbolism is also important to study because it may reveal to what extent human's different cognitive modalities (e.g. sounds and visions) interact with one another [38].

Against this theoretical background, [1] studied sound symbolic patterns in Japanese Pokemon names (see also [39]). One of the main findings, which this paper further explores with experimentation, is that when a Pokemon character undergoes evolution, its name is more likely to contain voiced obstruents and is more likely to be longer in terms of mora counts. Voiced obstruents are a set of sounds (/b/, /d/, /g/, /z/) which are produced with a narrow or completely closed stricture in the oral cavity, together with glottal vibration, which involves delicate articulatory coordination [40]. Moras are basic counting units in Japanese, which include a vowel (optionally preceded by a consonant), a coda nasal, and the first half of a geminate [41–45]. Moras, rather than segments or syllables, are used in [1] and in this paper, because the moras are arguably the most psycholinguistically prominent counting units for Japanese speakers [46–48], though cf. [42, 49]. In this paper, we explore whether the specific sound symbolic patterns found in [1] are productive in the minds of general Japanese speakers, or these patters merely exist in the "Pokemon" lexicon; i.e. the sound symbolic patterns identified by [1] are some conventions that are used by the designers of Pokemon games. These two possibilities are not mutually exclusive of one another, however. There is a third possibility that speakers can actually "learn" stochastic sound symbolic patterns from the Pokemon lexicon. We address this third possibility by analyzing the responses against the participants' familiarity with Pokemon.

We would like to emphasize at this point in the paper that, in addition to its research value, this project can be extremely useful in phonetics education. Phonetics is sometimes hard to teach in undergraduate education, because it could be overwhelming to some students, as it involves physiology (e.g. the structure of a larynx), mathematics (e.g. dB as a log function of Pascal) and physics (e.g. properties of sine waves, and FFT or DCT in acoustic analyses). However, since many students are familiar with Pokemon, this project has proven to be useful in lowering the psychological boundary to learn phonetic concepts for some students. Teaching that low frequency energy during stop closure in voiced stops may affect Pokemon naming patterns (see below) can be exciting. It is hoped that this paper also helps students to experience how linguistic experiments can be conducted through fun materials, like Pokemon names. We will come back to the potential educational application of these materials at the end of the paper.

Experiment 1

The first task was a free elicitation task. In this task, the participants were presented with a pair of two Pokemon characters, one pre-evolution version and the other post-evolution version. Within each trial, they were provided with one pair of two Pokemon characters, and they were asked to name both the pre-evolution and the post-evolution versions. This free elicitation task has been deployed in some previous studies of sound symbolism (e.g. [27, 50]). A more common paradigm in the studies of sound symbolism may be a forced-choice task, which we do report in Experiment 2, but it has a potential danger of the sound symbolic effects potentially "depend[ing] largely on the experimenter pre-selecting a few stimuli that he/she recognizes as illustrating the effects of interest" [51] (p.11) (see also [52]). Therefore, we started with a free naming task.

Method

Procedure

The participants were first told that the experiment was about naming new, non-existing Pokemon characters. They were asked to freely name each Pokemon character, with a few restrictions. First, they were asked to use *katakana* orthography, which is used for nonce words in the Japanese orthographic system. This instruction was given to discourage the participants from using real words, as sound symbolic patterns would be more likely to emerge with nonce words than with real words, because the sound-meaning relationships in real words are after all generally arbitrary [5, 6] (though cf. [28, 30, 53]). The participants were also asked not to simply translate the Pokemon characters into English, and were also asked to avoid using existing Pokemon names (to the extent that they know). They were also asked to avoid expressing evolution with existing prefixes like *mega* "mega", *gureeto* "great" or *suupaa* "super", or express pre-evolution versions with such prefixes as *mini* "mini" or *beibii* "baby". They were asked to try to use different forms for a pre-evolution and a post-evolution version (to the extent they know real Pokemon names).

After the instructions, the main trial session started. Within each trial, they were given a pair of a pre-evolution and a post-evolution version of Pokemon characters; a few example pairs are given in Fig. 1 for the sake of illustration. These pictures are drawn by *toto-mame*, who is an active drawer at `http://www.pixiv.net/`, an online forum to share self-drawn pictures. These pictures are reproduced here with the permission of the drawer. The pictures were judged by many Pokemon players to "look like real Pokemon." Within each pair, the two Pokemon characters are drawings of the same motif (e.g. bat or dog), so that it is clear that each pair is related via evolution. Twenty such pairs were used for this experiment. The order of these pairs was randomized per participant. After the main trials, some demographic questions were asked. There was an additional question of how familiar they are with Pokemon using a 1-to-7 scale, where higher numbers indicate more familiarity with Pokemon.

Fig 1. Sample stimuli. Sample stimulus pairs of pre-evolution and post-evolution Pokemon characters, which were used in the all three experiments reported in this paper. The pictures are produced here with the permission of the drawer.

Participants and data analysis

The experiment was conducted as an online survey using surveymonkey. All the participants read the consent form before they started the experiment. The consent form that was used was approved by the Board of the Keio Institute of Cultural and Linguistic Studies. The order of the trials was randomized per participant. Two participants reported that they had studied sound symbolism; their data were excluded, in order to exclude any potential bias due to their knowledge about sound symbolism. One participant used the same name for both pre-evolution and post-evolution characters, and another participant used too many mono-moraic names, which were judged to be too unnatural for Japanese names: although there are mono-moraic nouns in Japanese (e.g. *ki* ‘tree’), Japanese names are usually at least two-mora long [54]. Responses from these speakers were excluded. The data from 108 participants remained for the following analysis.

Some specific responses were also excluded. For example, some post-evolution characters were expressed via prefixation (e.g. *girasu* → *dosu-girasu*). Although *dosu* is not an existing prefix, we excluded such cases to be conservative. Prefixation with *dosu* necessarily increases the number of a voiced obstruent and mora counts (we would like to note, however, that the use of this prefix is in conformity with the sound symbolic patterns that we are investigating in that it contains a voiced stop, /d/). There were some cases in which the post-evolution is a complete superset of the pre-evolution (i.e. it looks like infixation; e.g. *kurin* → *kurion*). Although infixation does not exist as a productive morphological process in Japanese, we also excluded such cases, again to be conservative (infixation necessarily results in increased mora counts). Cases in which pre-evolution and post-evolution were expressed via different prefixes (*ko* “small” vs. *oo* “big”) were also excluded, because such cases were clearly semantics-driven. Finally, the a few cases in which the responses did not follow Japanese phonotactics were excluded. The remaining responses consisted of 1883 pairs of Pokemon characters.

Results

Consistent with the results of [1], the overall average mora counts increased from the pre-evolution version (3.89) to the post-evolution version (4.55). Likewise, the overall average number of voiced obstruents increased from 0.40 to 0.80. Some illustrative examples include *ri-ri-i-ra* → *yu-re-i-do-ru*, *ba-ru-cha-i* → *ba-ru-chi-i-na*, and *ka-me-te-te* → *ga-me-i-do-su* (where “-” represents a mora boundary; voiced obstruents are shown with underline). The results thus support the findings by [1] that the post-evolution Pokemon characters are more likely to be assigned with names that have voiced obstruents and names that have higher mora counts.

To statistically assess the impact of these two factors on the pre- vs. post- evolution distinction, a logistic linear-mixed model [55, 56] was run with subject and item as random factors, and mora counts and the number of voiced obstruents, as well as its interaction, as fixed factors. The dependent variable was the pre-evolution vs. post-evolution distinction. The results reveal that the effect of mora counts was highly significant ($\beta = 0.75, z = 14.77, p < .001$), so was the effect of voiced obstruents ($\beta = 1.55, z = 6.89, p < .001$). The interaction was also significant ($\beta = -0.23, z = -4.47, p < .001$). To interpret this interaction, we fit a linear mixed model for each mora length, and examined the effects of voiced obstruents on the pre- vs. post- evolution distinction. The estimates of the coefficient indeed changed as a function of mora length: 2 mora ($\beta = 0.84, z = 2.44, p < .05$), 3 mora ($\beta = 0.98, z = 6.63, p < .001$), 4 mora ($\beta = 0.59, z = 7.70, p < .001$), 5 mora ($\beta = 0.57, z = 5.35, p < .001$), 6 mora ($\beta = 0.06, z = 0.27, n.s.$), 7 mora ($\beta = 0.14, z = 0.44, n.s.$), 8 mora ($\beta = 0.37, z = 0.63, n.s.$) and 9 mora ($\beta = -0.20, z = -0.29, n.s.$). In short, the effects of voiced obstruents are robust between 2 mora-long names and 5 mora-long names, but not in names that are longer.

Next we compared two Pokemon characters within each pair. For each pair, we coded whether mora counts and the number of voiced obstruents increase, decrease, or stay constant. The skew in the distribution was assessed by a χ^2-test against the null hypothesis that distributions in these three conditions are uniform (i.e. the expected values were set to be $3/N$ where N is the total number of observations, 1883). The χ^2-tests were followed by residual analyses, which test whether the observed value in each cell is statistically higher/lower than expected by chance. Table 1 illustrates the results.

Table 1. The breakdown of within-pair analyses, with post-hoc residual analyses.

	# of voiced obs		mora counts	
increase	719 (38%)	$< .01(\uparrow)$	1055 (56%)	$< .001(\uparrow)$
decrease	185 (10%)	$< .001(\downarrow)$	190 (10%)	$< .001(\downarrow)$
constant	979 (52%)	$< .001(\uparrow)$	638 (34%)	*n.s.*
total	1,883		1,883	

Overall, the skew in Table 1 is significant in terms of the number of voiced obstruents ($\chi^2(2) = 324.0, p < .001$), and mora counts ($\chi^2(2) = 342.7, p < .001$). Furthermore, the residual analyses reveal that both for the number of voiced obstruents and for the mora counts, "the increase category" is overrepresented, whereas "the decrease category" is underrepresented. These results again confirm the psychological reality of the patterns identified by [1].

Discussion

The sound symbolic patterns

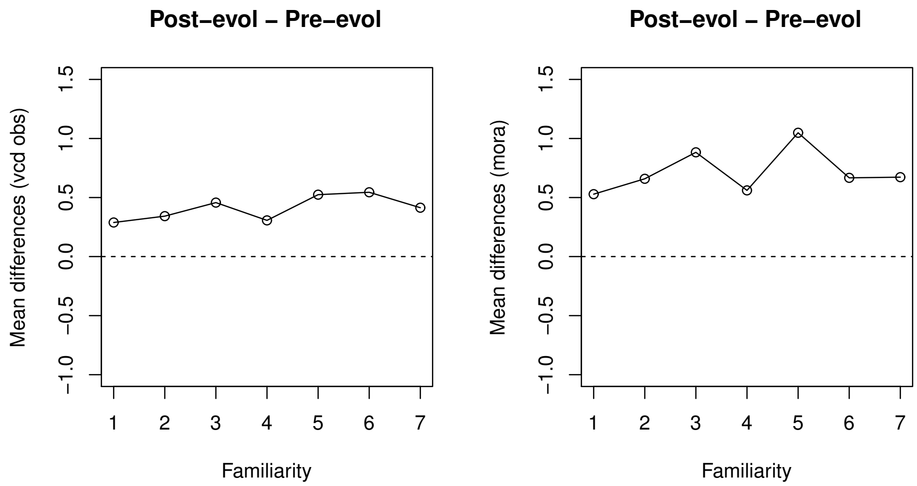
It seems safe to conclude that Japanese speakers show stochastic tendencies to associate voiced obstruents with post-evolution Pokemon characters. They are also more likely to associate longer mora lengths with post-evolution Pokemon characters. The reason why these patterns hold is an interesting question. One possibility, for the effect of voiced obstruents, is Ohala's Frequency Code Hypothesis [31–33]. Voiced obstruents are characterized by low frequency energies both during their constriction and in surrounding vowels ([57–62]—see [63] for the acoustic data from Japanese). The Frequency Code Hypothesis predicts, therefore, that voiced obstruents imply large objects because of their low frequency components, and since Pokemon characters generally become larger and heavier after evolution, the presence and the number of voiced obstruents should impact the naming of post-evolution Pokemon characters.

A possible reason for the effect of mora counts may come from the fact that in Japanese, male names are longer than female names [64]. Post-evolution characters usually have high physical strength parameters, which may be prototypically associated with masculinity. This hypothesis makes a prediction that is testable with English speakers' behavior: in English, male names tend to be shorter than female names [65–67], and therefore, if this hypothesis is correct, English speakers should prefer shorter names for post-evolution Pokemon characters. This possibility is addressed in Experiment 3. Alternatively, there may be a simple sound symbolic relationship in such a way that "mora sounds = heavier, larger, stronger," although to our knowledge, such sound symbolic patterns have not been systematically demonstrated for natural language patterns.

The effects of familiarity

We further explored the data to examine whether familiarity with Pokemon influenced the names they assigned in the experiment. To do so, Fig. 2 plots, by familiarity level, the differences between post-evolution forms and pre-evolution forms in terms of the average number of voiced obstruents (left) and the average mora counts (right). The positive numbers indicate that the number of voiced obstruents and the number of moras increased after evolution.

Fig 2. Familiarity effects in Experiment 1. The differences between post-evolution forms and pre-evolution forms in terms of the average number of voiced obstruents (left) and the average mora counts (right), plotted by familiarity level. The numbers of responses for each familiarity level = 76, 90, 124, 763, 256, 328, 246.



First, starting with the right panel, we observe that, regardless of the familiarity level, the differences in the number of mora counts are observed more or less constantly, and actually there is no correlation between the two factors ($r = 0.04, t = 1.66, n.s.$). On the other hand, for the differences in the number of voiced obstruents (the left panel), there is a slight increase as the familiarity level goes up ($r = 0.05, t = 2.35, p < .05$), although the effect size of this correlation is very weak. This correlation suggests that people with more exposure to Pokemon use names that are more heavily influenced by the sound symbolic patterns that exist in the real Pokemon names. This possibility is further taken up in Experiment 2.

Experiment 2

Experiment 2 was a forced-choice task experiment. Although the forced-choice task format may potentially have a disadvantage of the experimenters selecting those stimuli that they already think would work before the experiment [51], it also has a virtue of allowing experimenters to control parameters that are of interest. For example, we can use strictly mono-morphemic nonce words, which avoids the problem of affixation that came up in the analysis of Experiment 1. Also, this task is easier for the participants than the elicitation task—it is easier to choose from the options provided than to come up with new names out of scratch. Hence, we were able to include more trials in this experiment than in Experiment 1. In order to address the potential concern of the stimuli being possibly biased by the experimenters, we used a random name generator.

Method

Stimuli

The experiment had four conditions: the first two conditions tested the effect of voiced obstruents, and the next two conditions tested the effect of mora counts. Each condition had 10 items. The list of the stimuli is provided in the appendix. We avoided using minimal pairs—while minimal pairs would probably have shown clearer results, using minimal pairs would easily reveal the targets of the study to the participants.

In the first condition, the pair of names contrasted in terms of the presence of a voiced obstruent, while both of the names are three mora long (e.g. *mureya* vs. $\underline{z}$*uhemi*). The position of a voiced obstruent was varied across the first, second and third position. The second condition tested the number of voiced obstruents, in such a way that one item contained one voiced obstruent and the other contained two (e.g. $\underline{b}$*onechi* vs. $\underline{g}$*u*$\underline{d}$*eyo*). In the third condition, one name was three mora long with all light syllables (e.g. *sa-ki-ro*) and the other name contained a long vowel at the end, hence being four mora long (e.g. *ho-ki-ne-e*). The last condition compared four mora long names and five mora long names, and all syllables were light syllables (e.g. *to-ku-su-hi* vs. *mo-no-he-hi-ta*). No voiced obstruents appeared in any of the stimuli for the last two conditions. All of the names were created by an online random name generator, which randomly combines Japanese (C)V-moras (`http://bit.ly/2iGaKko`). Since the name generator rarely produced a word-final long vowel, we created the stimuli with a long final vowel by lengthening the final vowels of CVCVCV output forms.

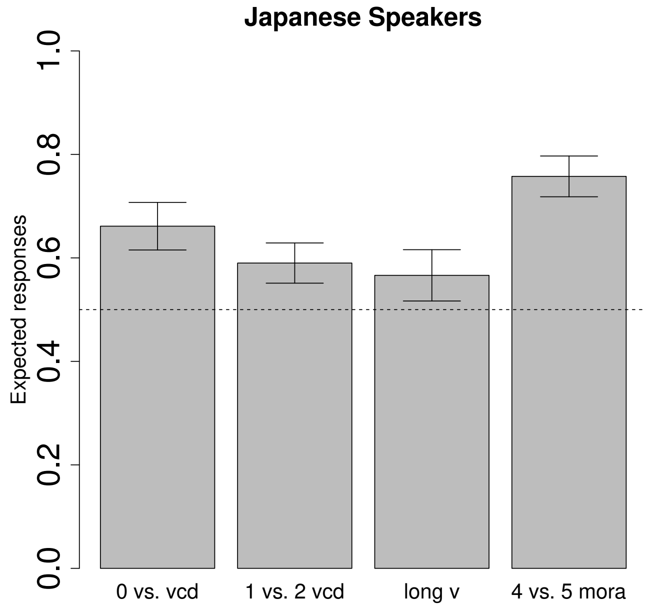
Procedure and Participants

Experiment 2 was also administered via surveymonkey. The pictures used in this experiment were of the same kind as those used in Experiment 1, and actually they were a superset of what was used in Experiment 1. There were a total of 40 questions. The order between these questions was randomized per participant. One participant was not a native speaker of Japanese. Another speaker said that s/he studied sound symbolism before, and hence was excluded. The following analysis is based on the data from the remaining 80 speakers.

Results

Fig. 3 shows the average expected responses, with the error bars representing 95% confidence intervals. Recall that the expected responses mean that the post-evolution Pokemon characters are associated with a name with a voiced obstruent (leftmost bar), a name with two voiced obstruents (2nd bar), a name with a word-final long vowel (3rd bar) and a name with 5 moras (the rightmost bar). For each condition, the means are above the chance level. A one-sample t-test compared the observed patterns against the null hypothesis that responses are random, which shows that the skews are all significant (0 voiced obstruent vs. 1 voiced obstruent: average=0.67, $t = 7.42, p < .001$; 1 voiced obstruent vs. 2 voiced obstruents: average=0.60, $t = 4.83, p < .001$; no long vowel vs. final long vowel: average=0.57, $t = 2.55, p < .05$; 4 moras vs. 5 moras: average=0.76, $t = 13.1, p < .001$). We note, however, that the effect sizes are not very large, the means distributing around and above 60%, except for the last condition which seems more robust (above 75%). This observation may not be very surprising given that sound symbolic patterns are, after all, stochastic.

Fig 3. Results of Experiment 2. The average expected response ratios in Experiment 2. The error bars represent 95% confidence intervals.



Discussion

The sound symbolic effects

The first two conditions in Fig. 3 show that Japanese speakers are sensitive to both the presence and the number of voiced obstruents when choosing names of post-evolution Pokemon characters. The last two conditions in Fig. 3 show that Japanese speakers are sensitive to mora counts of names, when deciding which option is better for post-evolution Pokemon characters. In terms of effect size, the addition of a CV mora is most robust (the fourth plot). Since the effect sizes were otherwise not very large, we explored the data further in terms of inter-speaker variation, using a boxplot shown in Fig 4.

Fig 4. A boxplot of the results Experiment 2. The upper lines of the boxes show 75% quantiles, the lower lines 25% quantiles. The thick bars in the boxes show medians. Circle represents outliers that are outside of the means ± 2SD.

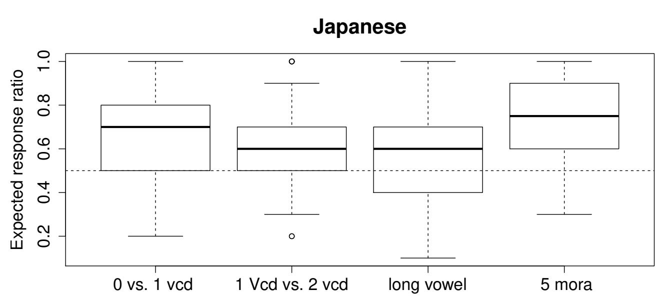


Fig. 4 shows that there are participants whose scores are below the chance level, as the lower lines of the boxes (25% percentile) are placed near or below the 50% chance line, except for the last condition. Especially, there seems to be a large inter-speaker variability for the long vowel condition (the third plot). It suggests that not everybody chose Pokemon's names based on the specific sound symbolic patterns that we have been discussing (the number of voiced obstruents and mora counts). Therefore, there are non-negligible degrees of inter-speaker variation: indeed they are some participants who chose "unexpected" responses more than "expected" responses. It could be the case that, there are some other sound symbolic factors, yet to be found out, which have blurred the results. See the final discussion section for potential examples of other sound symbolic patterns.

Positional effects?

In the first condition, the position of voiced obstruents was varied between C1, C2, and C3. We know from a body of psycholinguistic work that word-initial positions are psychologically prominent (e.g. [68–73]), and as such, privileged phonologically [74–76]. [77] investigated the positional effects in sound symbolism, and showed that voice obstruents in word-initial position indeed cause stronger images with Japanese listeners than voiced obstruents in word-medial or word-final position. The current data from the first condition allows us to assess whether sound symbolism is more prominent in initial syllables than in medial syllables. To that end, Table 2 shows the results of each item of the first condition, broken down by item.

Table 2. Expected response ratio by position of the voiced obstruent. Name 1=those that include a voiced obstruent; Name 2=Competitor; Name 1 Res. = number of times Name 1 "beat" Name 2.

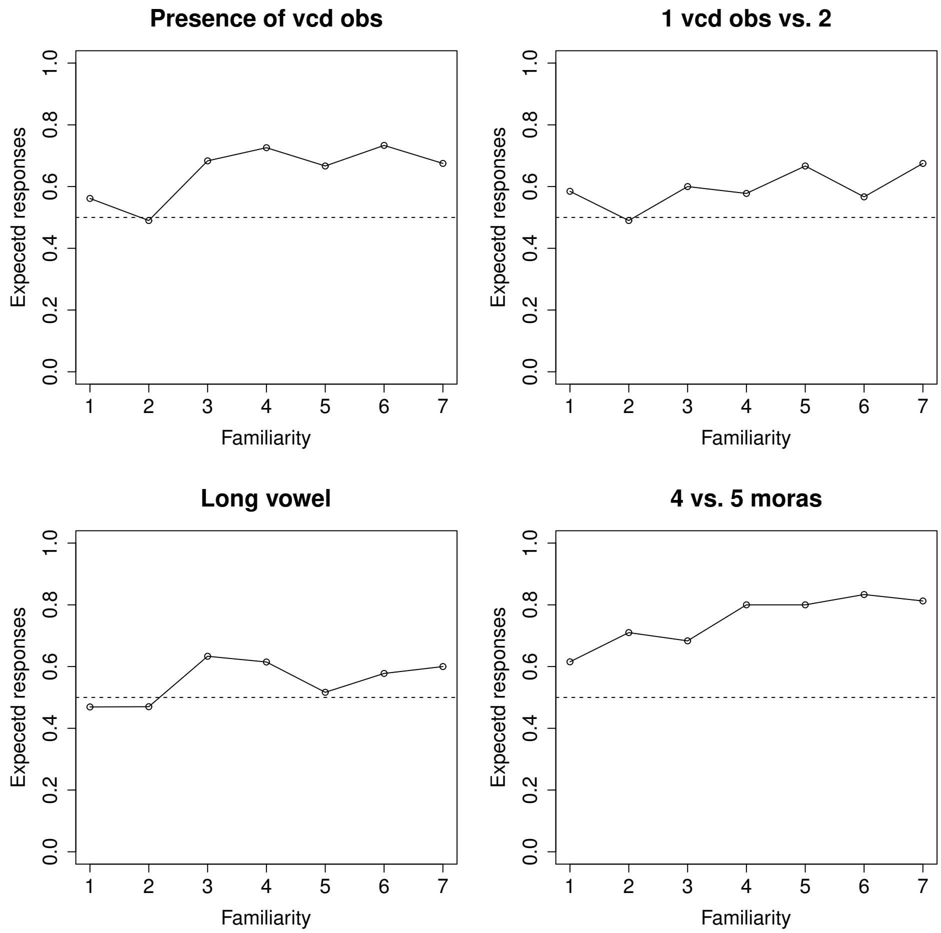
position	C1	C1	C1	C2	C2	C2	C3	C3	C3	C3
name 1	domana	zuhemi	zetemu	negemu	mabiho	tazuri	furiba	tohoze	hafubi	ruyoga
name 2	hifuho	mureya	ritoha	matoha	mishimi	riyare	nehoma	tsurera	karuno	satora
name 1 res.	63	42	74	56	51	54	44	51	40	54

The results are not straightforward yet telling—two out of the three items (*domana* and *zetemu*) show the highest expected responses, which is compatible with the prediction that voiced obstruents in word-initial position cause stronger sound symbolic effects. However, *zuhemi* behaves exceptionally in this regard—it showed one of the lowest expected responses. The data is thus not conclusive, but new experiments with Pokemon, with further items, can shed new light on the issue of positional effects in sound symbolism.

Effects of familiarity

As with Experiment 1, we further investigated the data in terms of whether familiarity with Pokemon affected how often they chose expected responses. Fig. 5 shows the average expected responses broken down by familiarity. Overall, there are positive correlations, which means that the more familiar the speakers were with Pokemon, the more likely they chose expected responses. The correlations were significant for two of the four conditions (the presence of a voiced obstruent: $r = .29, t = 2.69, p < .01$; the number of voiced obstruents: $r = .17, t = 1.49, n.s.$; long vowel: $r = 0.19, t = 1.66, n.s.$; mora counts: $r = .38, t = 3.63, p < .001$.)

Fig 5. Familiarity effects in Experiment 2. The average expected responses in Experiment 2, broken down by familiarity level. The number of participants (not responses) for each familiarity levels are: 13, 10, 6, 27, 6, 9, 8.



Compared with the results of Experiment 1, the correlations seem stronger: there may be effects from the "Pokemon" lexicon on the judgment patterns obtained in the current experiment, in such a way that the participants (unconsciously) had learned the sound symbolic relationships that exist in the real Pokemon characters.

We know that phonological knowledge is very strongly—though arguably not entirely—affected by the statistical properties in the lexicon [78–83]. What the current results may be showing is that speakers can learn sound symbolic patterns from a particular set of data; i.e. the "Pokemon lexicon".

What is particularly noteworthy is the fact the expected response ratios float around the chance line for those whose familiarity level is lower than 2, except for the right-bottom panel. Recall that in Experiment 1, those who were not very familiar with Pokemon did show the specific sound symbolic patterns under question. We do not have a clear answer as to why we observe this difference between Experiment 1 and Experiment 2. It could be the case that those participants in Experiment 2 who were not familiar with Pokemon did not know that, with evolution, Pokemon characters become larger and heavier—i.e. they did have the sound symbolic knowledge about the relationship between voiced obstruents and largeness/heaviness, but they failed to apply that knowledge in this experiment, because they lacked knowledge about Pokemon.

Experiment 3

The final experiment targeted English speakers, with the same set of stimuli as Experiment 2. The purposes of this experiment were (i) to explore the question of the universality of sound-symbolic patterns observed so far, and (ii) to address the hypothesis that longer names are chosen for the post-evolution characters because Japanese male names are longer than female names. Recall that in English, if the length difference between male names and female names is responsible for the observed sound symbolic effect, the opposite pattern should hold, because male names are generally shorter than female names in English [65–67].

Method

Stimuli

In order to make the cross-language comparison easier, the same set of stimuli as Experiment 2 was used, except that *koemuna* was replaced with *kosemuna*, because it was not clear whether /oe/ sequence is phonotactically possible in English. In terms of stimulus presentation, long vowels are expressed orthographically as "ar" for *aa*, "ey" for *ee*, "ie" for *ii*, "ow" for *oo*, and "ew" for *uu*. All other aspects of the experiment were identical to Experiment 2.

Participants

The call for participants was announced on the authors' SNS pages, which were shared by our colleagues. The instructions of the experiment were almost identical to that of Experiment 2, except that they were given in English. Also, the participants were instructed to imagine that they were working for a Japanese company who is responsible for coming up with Pokemon names for the next generation, because the stimuli were "pseudo-Japanese". A surprisingly high number of participants (=33) reported that they have studied sound symbolism. The reason may be because since the call for participants was shared and advised by a number of university professors and graduate students, there may have been several student participants who learned about sound symbolism in their linguistics or psychology class. After removing these participants, 68 naive speakers remained for the analysis.

Results

Fig. 6 show the average expected responses for English speakers. All but the second conditions show statistical difference from random responses (0 voiced obstruent vs. 1 voiced obstruent: average=0.55, $t = 2.35, p < .05$; 1 voiced obstruent vs. 2 voiced obstruent: average=0.48, $t = -0.80, n.s.$; no long vowel vs. final long vowel: average=0.55, $t = 2.24, p < .05$; 4 moras vs. 5 moras: average=0.79, $t = 7.05, p < .001$). Though statistically significant, they—except for the last condition—are barely above chance. As the box plot in Fig. 7 shows, the medians are on the chance level for the second and third conditions; 50% of the people showed less than half of expected responses.

Fig 6. The results of Experiment 3. The average expected responses with 95% confidence intervals. The participants were limited to those who did not know about sound symbolism.

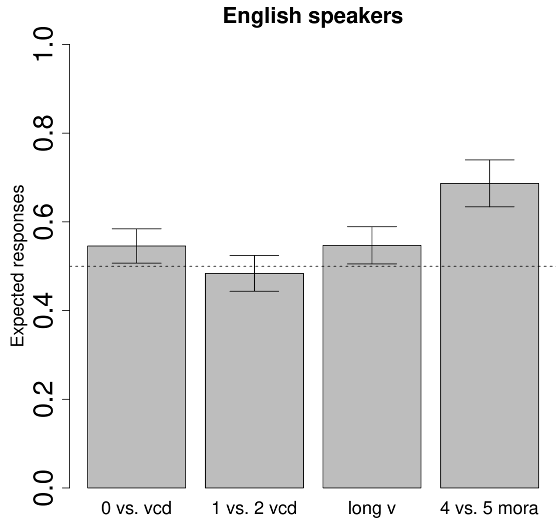
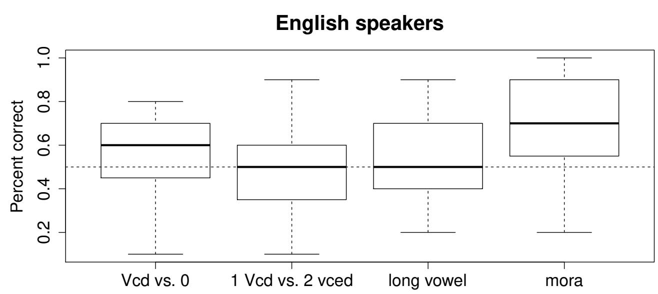


Fig 7. A boxplot of the results of Experiment 3.



Discussion

First, it seems safe to conclude that the addition of a CV mora robustly influences the judgment of the post-evolution Pokemon names even for English speakers. This result is not compatible with the hypothesis entertained above that the observed sound symbolic effect has its root in the different lengths of male names and female names. However, it does strengthen the "longer=stronger" relationship in sound symbolism from a cross-linguistic perspective.

The effect of the presence of a voiced obstruent was significant. Two previous studies have shown that English speakers associate voiced obstruents with large objects [22, 84], and therefore it is not too mysterious that English speakers would also associate voiced obstruents with Pokemon characters after evolution, although the effect size is small. However, no sensitivity to the difference between one voiced obstruent and two voiced obstruents was observed, unlike Japanese speakers.

Overall, the effect sizes are small (about 5% above chance for the first and third conditions). The boxplot shows that some speakers were not sensitive to the sound symbolic patterns under investigation. We used stimuli that are "psuedo-Japanese", as the original Pokemon names are in Japanese. However, it may be interesting to follow up with an experiment with more English-like nonce words.

Overall conclusion

The current experiments have found that (some) Japanese speakers associate voiced obstruents and higher mora counts to post-evolution Pokemon characters. Some English speakers too showed similar patterns, although the results were not as clear as those of Japanese speakers. These results confirm the previous corpus-based study [1], and further strengthen the existence of sound symbolic patterns in naming conventions (see [23, 85–87] for other studies which show sound symbolic effects in naming). However, we also note that not every participant followed the sound symbolic rules we examined, which suggests a nuanced view of sound symbolism. It probably suggests that the effects of voiced obstruents and mora lengths—not too surprisingly—do not entirely determine how Pokemon characters are named. There was also a large inter-speaker variability in terms of to what degrees they follow sound-symbolic principles—this is a topic that has been understudied, and needs more attention in future research.

More generally, we believe that what we found in this study, as well as in [1], is a tip of an iceberg. There are many more remaining tasks for this general project on the sound symbolic patterns of Pokemon names. The first one is the analysis of existing Pokemon names in English, which is on-going. (Unlike Japanese, the orthography-to-sound relationships are not very straightforward in English, and some efforts are necessary to convert written names to phonetic transcriptions.) Whether Japanese and English show the same sound symbolic patterns in their respective Pokemon lexicon is an interesting question to pursue, given the different results we obtained between Experiments 2 and 3. Another interesting question is the effect of vowel quality: in terms of sound symbolism, it is an old observation that low vowels are perceived to be larger than higher vowels, and back vowels are perceived to be larger than front vowels [2, 22, 50, 84]. The effects of vowels, and possibly other factors, may have been at work in Experiments 2 and 3, which could have resulted in the observed small effect sizes.

The overall results suggest the possibility that there may be sound symbolic patterns that are shared across languages [28, 84] as well as language-specific patterns [88–90]. On the one hand, the effects of mora counts—especially the addition of a CV syllable—were very robust for both Japanese and English speakers. On the other hand, the difference between 1 voiced obstruent and 2 voiced obstruents was observed only with Japanese speakers. We are looking forward to addressing the issue of universality and language specificity of sound symbolic patterns with speakers with different language background. Since Pokemon is translated into many different languages, and people from many different language backgrounds are familiar with Pokemon, the sound symbolic study of Pokemon names offers a forum to investigate the issue of the universality and language-specificity of sound symbolic patterns. In general, the current results raise interesting questions for future research in sound symbolism. In addition to those that have been discussed above, the effects of Pokemon familiarity on the robustness of sound symbolic patterns are intriguing and worth more investigations. Put more generally, what is the role of the lexicon in shaping speakers' intuitions about sound symbolism? As far as we know, this question has been understudied, especially compared to the studies on how phonotactic judgment patterns are shaped by lexical statistics in the lexicon [78–83].

We would like to close this paper with one final remark. In addition to the research values of the current project, we would like to highlight its potential contribution to undergraduate phonetics education. Perhaps many of us have experienced difficulty in teaching phonetics in undergraduate education. The challenge is partly due to the nature of the subject matter. In order to understand phonetics, it is necessary to have some background in mathematics and physics, which could be overwhelming to some. However, teaching the Frequency Code Hypothesis with Pokemon would be useful in teaching why it matters to talk about “low frequency energies”.

Although we have not tested this quantitatively, our experience is that using this project as an illustration of phonetic research lowers the psychological boundary of some students. The numbers of participants we gathered for this paper (ca. 200 Japanese speakers and 100 English speakers) are indicative—many were willing to volunteer in the online experiments because they thought that an experiment on Pokemon would be fun. We hope that as we further explore the sound symbolic nature of Pokemon names, we will identify more patterns which can be deployed to teach more phonetic concepts. And we are optimistic about this possibility—for example, if we find that vowel quality, especially its F2, affects the evolution level, we could present to students F2 as “something real”. Another aspect in which we find Pokemon to be useful to use in education is the fact that Pokemon has many features that we have not explored. For example, one student pointed out to us that some Pokemon characters are “legendary Pokemon”, and asked whether some special sound symbolic patterns are used to express them. Another student told us that Pokemon characters are categorized into types, such as “Fire”, “Ice”, and “Ghost”, and asked whether there are “type-specific” sound symbolism. (We have encouraged them to investigate these questions themselves.) This feature of Pokemon allows students to come up with new topics of exploration themselves, thereby allowing us to engage in student-oriented exploration of new hypotheses.

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Appendix

Table 3. The stimuli for Experiments 2 and 3.

condition 1	No voiced obstruents	1 voiced obstruent
	hifuho	*domana*
	mureya	*zuhemi*
	ritoha	*zetemu*
	matoha	*negemu*
	mishimi	*mabiho*
	riyare	*tazuri*
	nehoma	*furiba*
	tsurera	*tohoze*
	karuno	*hafubi*
	satora	*ruyoga*
condition 2	1 voiced obstruent	2 voiced obstruents
	bamachi	*bedeme*
	gasoyu	*zazohi*
	bonechi	*gudeyo*
	genefu	*darobe*
	goyamu	*goruzu*
	dosora	*dokuba*
	zeyuri	*berada*
	sozafu	*yabude*
	najiyo	*kuguji*
	hodamo	*neguzu*
condition 3	All light syllables	Final long vowel
	sakiro	*hokinee*
	sukihi	*muhuraa*
	saheshi	*kishimaa*
	tsumohi	*kutonaa*
	wasehe	*momuruu*
	samimu	*tsunokee*
	wakeya	*korunii*
	rihepi	*mekiree*
	soromo	*semafuu*
	raneho	*myusaroo*
condition 4	4 light syllables	5 light syllables
	hukoyota	*norutehume*
	tokusuhi	*monohehita*
	henaroho	*noshiyohoya*
	manoyaki	*miyarifuchi*
	mumotoke	*yaserenama*
	nushikoya	*haretamonu*
	harochifu	*homiherori*
	sunemaro	*taharohore*
	fuchikeho	*hisahemetsu*
	ko(s)emuna	*takimekama*

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