# Expressing evolution in Pokémon names: Experimental explorations

### 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. A previous corpus-based research identified some specific sound symbolic relationships in Pokémon naming patterns in Japanese (Anonymous, 2016). One of the main findings was that the names of Pokémon characters are more likely to contain voiced obstruents and are longer in terms of mora counts, when they undergo evolution (e.g. *nyoromo* → *nyoroz̲o*; *poppo* → *pij̲otto*). The current study reports three experiments that test whether (i) these patterns are productive in the minds of general Japanese speakers, and whether (ii) the same tendency would hold with English speakers. The results show that the effect of mora length was clearly observed both with Japanese and English speakers; the effects of voiced obstruents were observed clearly with Japanese speakers, but less clearly with English speakers. Besides its research value, we argue that this general project can be useful for undergraduate phonetics education.

## 1 Introduction

### 1.1 Synopsis of the paper

This paper reports an experimental case study of sound symbolism, patterns in which particular sounds are associated with particular meanings (Sapir 1929 *et seq*). The empirical target is the names of Pokémon characters, following the corpus-based study previously reported by Anonymous (2016). Pokémon 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 Pokémon games, many though not all Pokémon characters undergo evolution, and parameter-wise, they generally get stronger, heavier and larger after evolution (see below for detailed illustration). Anonymous (2016) studied more than 720 Japanese Pokémon 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 Pokémon characters are (i) more likely to include voiced obstruents and (ii) are longer in terms of mora counts. As a next step after this corpus study, this paper reports a series of experiments that explore the productivity of these sound symbolic associations.

## 1.2 Background

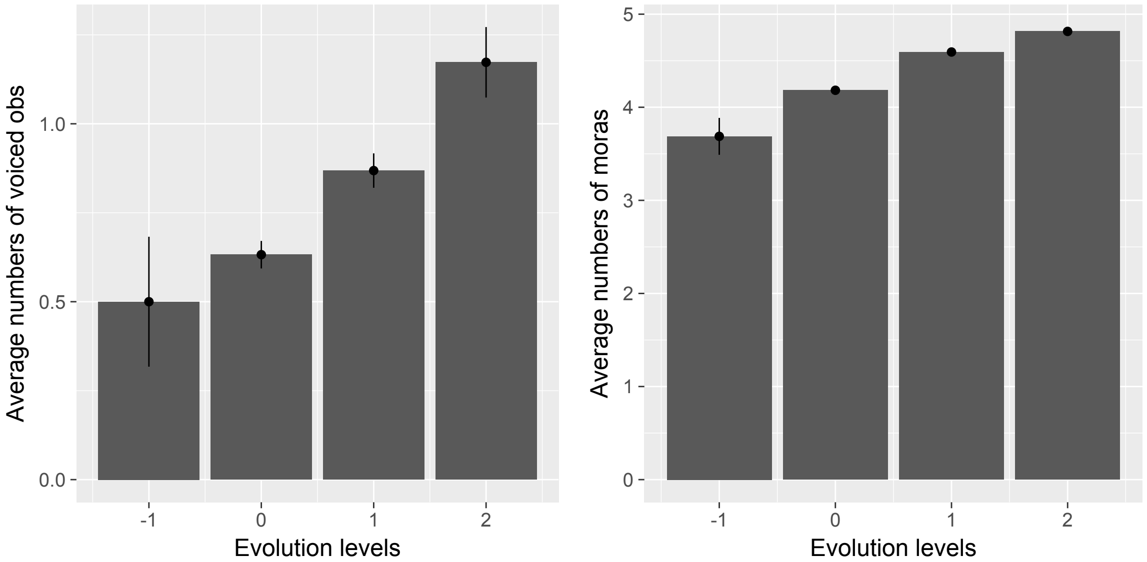
Let us briefly review the theoretical history of sound symbolism. Whether sounds themselves have meanings or not has been a matter of debate since the time of Plato (Plato, nd). In modern linguistics, the relationship between sounds and meanings was assumed to be arbitrary, which was formulated as the first principle of languages by Saussure (1916). 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 (Chomsky, 1981, 1986, 1995), 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. Selkirk 1995).

However, not everybody who works on languages embraces the view that sound-meaning relationships are strictly arbitrary. A pioneering experimental study by Sapir (1929) 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 (1947), 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 also actively studied under the rubric of the *bouba-kiki* effect (Ramachandran and Hubbard, 2001). Many psychologists and cognitive scientists have followed up these observations (see the website by Kimi Akita for comprehensive bibliography lists: `http://bit.ly/2jsm5WG`).

Recent work has moreover explored the implications of sound symbolism in language acquisition (Imai et al., 2008; Nygaard et al., 2009), its interaction with more formal grammatical systems (Alderete and Kochetov, 2017), language evolution (Berlin, 2006; Ramachandran and Hubbard, 2001), and language universals (Blasi et al., 2016; Dingemanse et al., 2013; Wichman et al., 2010). See Dingemanse (2012), Dingemanse et al. (2015) and Lockwood and Dingemanse (2015) for more extended reviews. In short, while languages can associate meanings and sounds in an arbitrary way, as Saussure (1916) formulated, there can be stochastic tendencies to connect sounds and meanings in systematic ways as well. Studying sound symbolism is important for linguistics, especially because it may have to do with 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 (Spence, 2011).

Against this theoretical background, Anonymous (2016) studied sound symbolic patterns in the actual Japanese Pokémon names. One of the main findings, reproduced here as Figure 1, is that when a Pokémon character undergoes evolution, its name is more likely to contain voiced obstruents and its name is more likely to be longer in terms of mora counts. Many Pokémon characters undergo evolution, at most twice, and when they do, they generally get stronger, heavier, and larger (see Figure 3 for details). In Figure 1, these evolution levels are coded as "0" (no evolution), "1" (1 step of evolution), and "2" (2 steps of evolution). Some Pokémon appeared as a pre-evolution version of an already existing Pokémon in a later series, which is called "a baby Pokémon". In Figure 1, such "baby" Pokémon characters are coded as "-1". The y-axes represent the average number of voiced obstruents (left) and the number of mora counts (right) in their names. 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 (Ito, 1989; Kubozono, 1999).[1]

Figure 1: The correlations between evolution levels on the one hand and the number of voiced obstruents in their name (left) and the number of moras (right), found in the corpus study (Anonymous, 2016). The error bars represent standard errors.



Anonymous (2016) thus observes that in the existing set of Pokémon characters, evolution is sound-symbolically represented by the presence/number of voiced obstruents in their names, as well as by the number of mora counts. However, one question that is unresolved in Anonymous (2016) is whether these effects are simply conventions deployed by the Pokémon designers, or

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[1] Moras, rather than segments or syllables, are used in Anonymous (2016) and in this paper, because the moras are arguably the most psycholinguistically prominent counting units for Japanese speakers (Otake et al. 1993, though cf. Cutler and Otake 2002).

intuitions shared by general Japanese speakers more broadly. In this paper, we thus explore whether the specific sound symbolic patterns found in Anonymous (2016) are productive in the minds of general Japanese speakers.

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. FFT in acoustic analyses). However, since many students are familiar with Pokémon, this project has proven to be useful in lowering the psychological boundary to learn phonetic concepts for some students. It is hoped that this paper also helps students to experience how linguistic experiments can be conducted through fun materials, like Pokémon names. We will come back to the potential educational application of these materials at the end of the paper.

# 2 Experiment 1

The first task was a free elicitation task. In this task, the participants were presented with a pair of two Pokémon characters, one pre-evolution version and the other post-evolution version. Within each trial, they were provided with one pair of two Pokémon 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. Berlin 2006; Shinohara et al. 2016). A more common paradigm in the studies of sound symbolism may be a forced-choice task, which we 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" (Westbury, 2005, p.11) (see also Dingemanse et al. 2016 for related discussion). Therefore, we started with a free naming task.

## 2.1 Method

### 2.1.1 Procedure

The participants were first told that the experiment was about naming new, non-existing Pokémon characters. They were asked to freely name each Pokémon 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 (Saussure, 1916). The participants were also asked not to simply translate the Pokémon characters into English, and were also asked to avoid using existing Pokémon 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 use different forms for a pre-evolution and a post-evolution version.

In the main trial session, within each trial, they were given a pair of a pre-evolution and a post-evolution version of Pokémon characters; a few example pairs are given in Figure 2 for the sake of illustration, drawn by a semi-professional digital artist. The pictures were judged by many Pokémon players to “look like real Pokémon.” Within each pair, the two Pokémon 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.

Figure 2: Sample stimulus pairs of pre-evolution and post-evolution Pokémon characters, which were used in the all three experiments reported in this paper. The pictures are produced here with the permission of the drawer.

### 2.1.2 Participants and data analysis

The experiment was conducted as an online survey using surveymonkey. 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. 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.[2] 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 existing prefixes (*ko* "small" vs. *oo* "big") were also excluded, because such cases were clearly semantics-driven. Finally, a few cases in which the responses did not follow Japanese phonotactics were excluded. The remaining responses consisted of 1,855 pairs of Pokémon names.

## 2.2 Results

Consistent with the results of Anonymous (2016), the overall average mora counts increased from the pre-evolution version (3.90) to the post-evolution version (4.56). Likewise, the overall average number of voiced obstruents increased from 0.44 to 0.80. Some illustrative examples include *ri-ri-i-ra* (4 moras) → *yu-re-i-do-ru* (5 moras), *ba-ru-cha-i* (4 moras) → *ba-ru-chi-i-na* (5 moras), and *ka-me-te-te* (4 moras) → *ga-me-i-do-su* (5 moras) (where "-" represents a mora boundary; voiced obstruents are shown with underline). The results thus support the findings by Anonymous (2016) that the post-evolution Pokémon 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 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 ($\beta = 0.74, z = 14.69, p < .001$), so was the effect of voiced obstruents ($\beta = 1.56, z = 6.97, p < .001$). The interaction was also significant ($\beta = -0.23, z = -4.50, p < .001$). 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 ($\beta = 0.91, z =$

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[2] 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/.

$2.54, p < .05$), 3 mora ($\beta = 1.02, z = 6.66, p < .001$), 4 mora ($\beta = 0.61, z = 7.84, p < .001$), 5 mora ($\beta = 0.57, z = 5.32, p < .001$), 6 mora ($\beta = 0.11, z = 0.56, n.s.$), 7 mora ($\beta = 0.20, z = 0.62, n.s.$), 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 Pokémon character names within each pair. For each pair, we coded whether mora counts and the number of voiced obstruents increased, decreased, or stayed constant. The skew was assessed by a $\chi^2$-test against the null hypothesis that distributions in the three conditions are uniform (i.e. the expected values were $3/N$). The $\chi^2$-test was 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 vcd obs | | mora counts | |
|---|---|---|---|---|
| increase | 707 (38%) | $< .01(\uparrow)$ | 1,034 (56%) | $< .001(\uparrow)$ |
| decrease | 182 (10%) | $< .001(\downarrow)$ | 189 (10%) | $< .001(\downarrow)$ |
| constant | 966 (52%) | $< .001(\uparrow)$ | 632 (34%) | $n.s.$ |
| total | 1,855 | | 1,855 | |

Overall, the skew in Table 1 is significant in terms of the number of voiced obstruents ($\chi^2(2) = 320.1, p < .001$), and mora counts ($\chi^2(2) = 333.0, p < .001$). 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 Anonymous (2016).

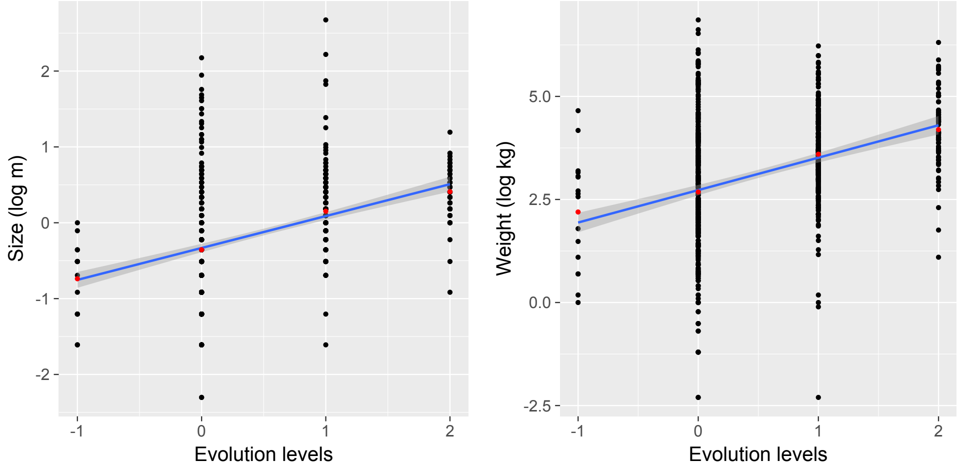
## 2.3 Discussion

It seems safe to conclude that Japanese speakers, even if they are not Pokémon designers, show stochastic tendencies to associate voiced obstruents with post-evolution Pokémon characters. They are also more likely to associate longer mora lengths with post-evolution Pokémon characters.

The reason why these patterns hold is an interesting question. One potential hypothesis regarding the effect of voiced obstruents—though we need to remain speculative about it at this point—is the Frequency Code Hypothesis (Ohala, 1994), which suggests that sounds with low frequency energy are generally perceived to be large and heavy. Voiced obstruents are characterized by low frequency energies both during their constriction and in surrounding vowels (Kingston and Diehl 1994; Stevens and Blumstein 1981—see Kawahara 2006 for the acoustic data in Japanese). The

Frequency Code Hypothesis predicts, therefore, that voiced obstruents imply large objects because of their low frequency components. Indeed, the experiment by Shinohara and Kawahara (2016) shows that Japanese speakers associate voiced obstruents with larger objects. As shown in Figure 3, in the Pokémon world, Pokémon characters generally become larger and heavier after evolution ($\rho = 0.51, p < .001$ and $\rho = 0.42, p < .001$). Therefore, it would not be too mysterious that the presence and the number of voiced obstruents can be significant factors in naming post-evolution Pokémon characters.

Figure 3: The correlations between evolution levels on the one hand, and size (left) and weight (right) on the other, in the existing Pokémon 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 (Mutsukawa, 2016). Post-evolution characters usually have high physical strength parameters—in the existing Pokémon character set, the correlation between the evolution levels and the sum of strength parameters is significant ($\rho = 0.51, p < 0.001$). In addition, "being physically strong" may be prototypically associated with masculinity. Therefore, since male names are longer in Japanese, evolved Pokémon names could become longer, mediated by the fact that masculinity and Pokémon evolution are both associated with physical strengths. This hypothesis makes a prediction that is testable with English speakers: in English, male names tend to be shorter than female names (Cutler et al., 1990; Wright et al., 2005), and therefore, if this hypothesis is correct, English speakers should prefer shorter names for post-evolution Pokémon 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 in natural languages.

# 3 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 (Westbury, 2005), 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.

## 3.1 Method

### 3.1.1 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 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. *z̲uhemi*). 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. *b̲onechi* vs. *g̲ud̲eyo*). 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`). Recall that this was to avoid the potential bias that we may have had in coming up with the stimuli. 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.

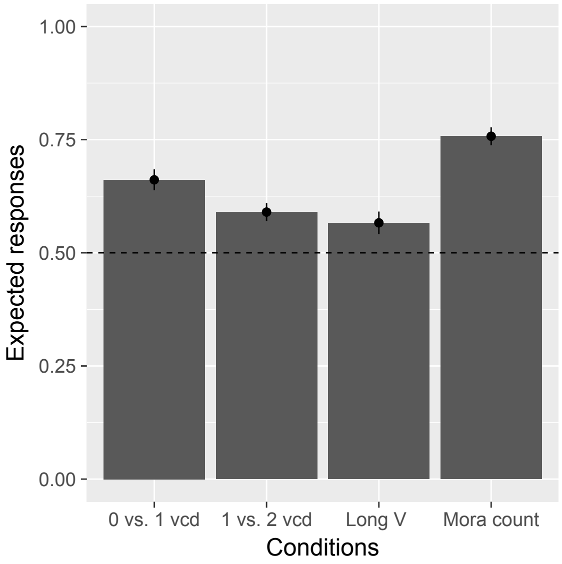
### 3.1.2 Procedure and Participants

Experiment 2 was also administered via surveymonkey. As with Experiment 1, within each trial, the participants were presented with a pair of pre-evolution and post-evolution Pokémon characters. They were asked which name should correspond to the pre-evolution version, and which name should correspond to the post-evolution version. The pictures used in this experiment were a superset of what was used in Experiment 1. There were a total of 40 questions. The order between the questions was randomized per participant. One participant was not a native speaker of Japanese. Another speaker reported that s/he studied sound symbolism before, and hence was excluded. The following analysis is based on the data from the remaining 80 speakers.

## 3.2 Results

Figure 4 shows the average "expected responses". Recall that the "expected responses" mean that the post-evolution Pokémon 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).

Figure 4: The average expected response ratios in Experiment 2. The error bars represent standard errors.



For each condition, the averages 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 (first bar: average=0.67, $t = 7.42, p < .001$; second bar: average=0.60, $t = 4.83, p < .001$; third bar: average=0.57, $t = 2.55, p < .05$; fourth bar: average=0.76,

$t = 13.1, p < .001$). We note, however, that the effect sizes are not very large, the averages 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.

## 3.3 Discussion

### 3.3.1 The sound symbolic effects

The first two conditions in Figure 4 show that Japanese speakers are sensitive to both the presence and the number of voiced obstruents when choosing names of post-evolution Pokémon characters. The last two conditions in Figure 4 show that Japanese speakers are sensitive to mora counts of names, when deciding which option is better for post-evolution Pokémon characters. In terms of effect size, the addition of a CV mora is most robust (the fourth bar). 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 Figure 5.

Figure 5: A boxplot of the results of Experiment 2.

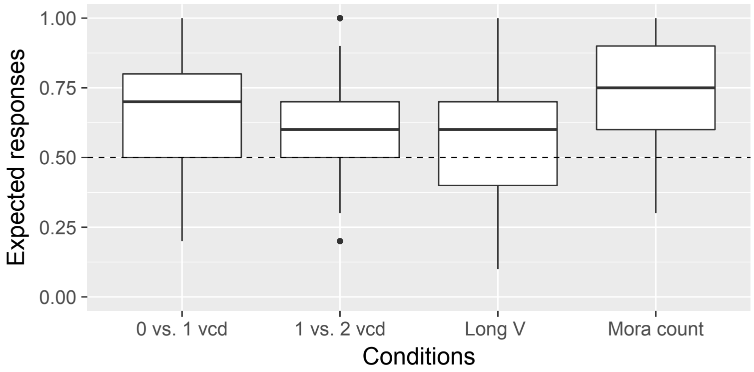
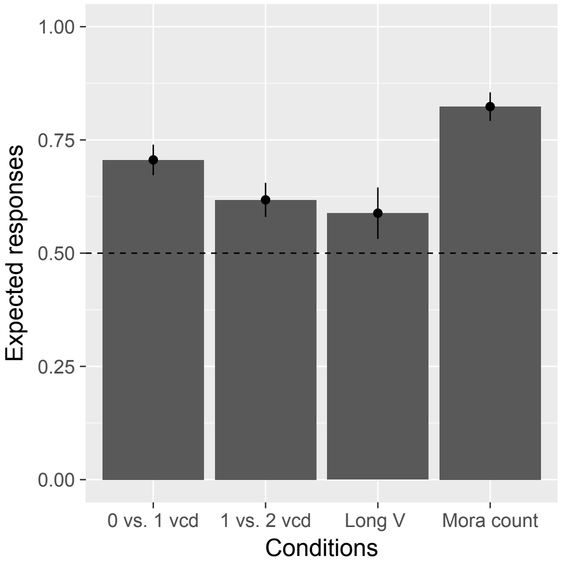


Figure 5 shows that there are participants whose scores are below the chance level, as the lower lines of the boxes (25% percentile) are placed near or below the 50% chance line, except for the last condition. Especially, there seems to be a large inter-speaker variability for the long vowel condition (the third plot). It suggests that not everybody chose Pokémon's names based on the specific sound symbolic patterns that we have been discussing (the presence/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, which may be lurking behind the Pokémon naming patterns.

### 3.3.2 Reanalysis with only those who do not know Pokémon

The general conclusion that we can draw from the results so far is that the sound symbolic relationships observed by Anonymous (2016) are not simply a matter of conventions used by the Pokémon designers. One may object to this conclusion because the participants may have been familiar with the existing Pokémon names. To address this question, we made use of a post-experimental questionnaire which asked how familiar they were with Pokémon using a 1-to-7 Lickert scale where ‘1’ was labeled as “never touched it” and ‘7’ was labeled “Pokémon is my life”. There were 17 speakers who chose two lowest points in answer to this question. Figure 6 shows the results of these participants, which is very similar to what we observe in Figure 4. Statistically, all the responses but the third condition are higher than the chance level (from left to right: $t = 6.10, p < .001; t = 3.12, p < 0.01; t = 1.55, n.s.; t = 10.3, p < .001$).

Figure 6: The results of Experiment 2 (those who are not familiar with Pokémon).



### 3.3.3 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. Nooteboom 1981), and as such, privileged phonologically (e.g. Beckman 1998). Kawahara et al. (2008) investigated the positional effects in sound symbolism with Japanese listeners, and showed that voice obstruents in word-initial position indeed cause stronger images 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 patterns, broken down 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 in the C1 condition (*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 Pokémon, with further items, can shed new light on the issue of positional effects in sound symbolism.

# 4 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 (Cutler et al., 1990; Wright et al., 2005).

## 4.1 Method

### 4.1.1 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.

### 4.1.2 Participants

The call for participants was announced on our 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 Pokémon 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 advertised by a number of university professors and graduate students, and 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.

## 4.2 Results

Figure 7 show the average expected responses for English speakers. All but the second conditions show statistical difference from random responses (from left to right: average=0.55, $t = 2.35, p < .05$; average=0.48, $t = -0.80, n.s.$; average=0.55, $t = 2.24, p < .05$; 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 Figure 8 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.

Figure 7: The average expected responses of Experiment 3.

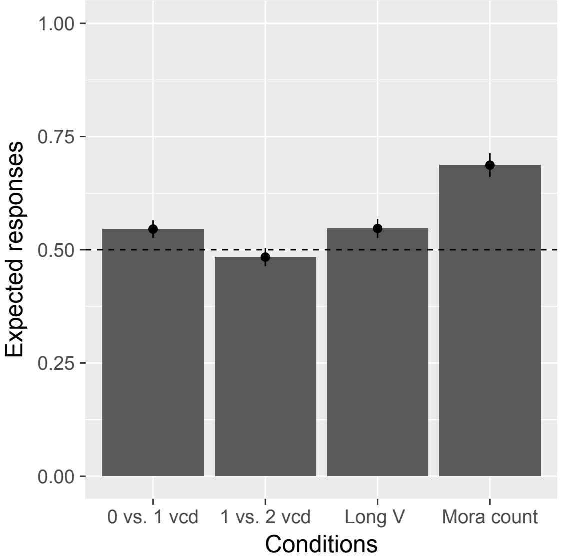
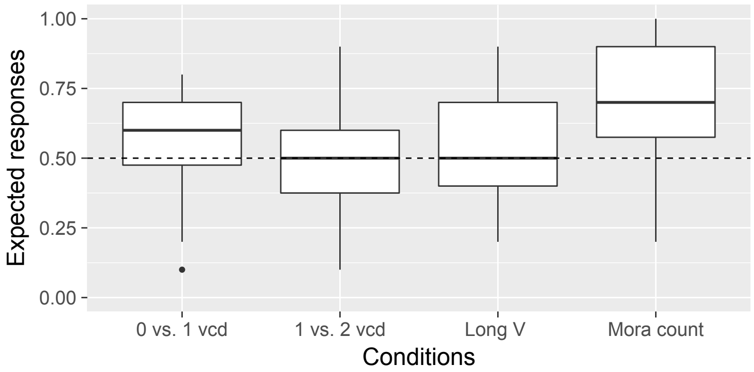


Figure 8: A boxplot of the results of Experiment 3.



## 4.3 Discussion

First, it seems safe to conclude that the addition of a CV mora robustly influences the judgment of the post-evolution Pokémon 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, although the question of why it holds remains unanswered.

The effect of the presence of a voiced obstruent was significant. Previous studies (Newman, 1933; Shinohara and Kawahara, 2016) showed that English speakers associate voiced obstruents with large images, and therefore it is not too mysterious that English speakers would also associate voiced obstruents with Pokémon 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 at all sensitive to the sound symbolic patterns under investigation. We used stimuli that are "psuedo-Japanese", as the original Pokémon names are in Japanese. Therefore, it may be interesting to follow up with an experiment with more English-like nonce words.

# 5 Overall conclusion

The current experiments have found that (some) Japanese speakers associate voiced obstruents and higher mora counts to post-evolution Pokémon 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 (Anonymous, 2016), and further strengthen the existence of sound symbolic patterns in naming conventions. 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 Pokémon characters are named. There was also a large inter-speaker variability in terms of to what degrees they follow the sound-symbolic principles—the inter-speaker variation in sound symbolism 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 Anonymous (2016), is a tip of an iceberg. There are many more remaining tasks for this general project on the sound symbolic patterns of Pokémon names. The first one is the analysis of existing Pokémon names in English, which is on-going. Whether Japanese and English show the same sound symbolic patterns in their respective Pokémon 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 (Newman, 1933; Ohala, 1994; Sapir, 1929; Shinohara and Kawahara, 2016; Shinohara et al., 2016; Ultan, 1978). 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 (Blasi et al., 2016; Shinohara and Kawahara, 2016) as well as language-specific patterns (Diffloth, 1994; Saji et al., 2013). 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 Pokémon is translated into many different languages, and people from many different language backgrounds are familiar with Pokémon, the sound symbolic study of Pokémon 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.

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 Pokémon 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 Pokémon would be fun. We hope that as we further explore the sound symbolic nature of Pokémon names, we will identify more sound symbolic 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 Pokémon to be useful to use in education is the fact that Pokémon has many features that we have not explored. For example, one student pointed out to us that some Pokémon characters are “legendary Pokémon”, and asked whether some special sound symbolic patterns are used to express them. Another student told us that Pokémon 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, instead of us depriving of their research opportunities. This feature of Pokémon allows students to come up with new topics of exploration themselves, thereby allowing us to engage in student-oriented exploration of new hypotheses.

# 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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