English speakers can infer Pokémon types based on sound symbolism*

Abstract

Sound symbolism, systematic associations between sounds and meanings, is receiving increasing attention in linguistics and related disciplines. One general question that is currently explored is what sorts of semantic properties can be symbolically represented. Against this background, within the general research paradigm which explores the nature of sound symbolism using Pokémon names, several recent studies have shown that Japanese speakers associate certain classes of sounds with notions that are as complex as Pokémon types. Specifically, they associate (1) sibilants with the flying type, (2) voiced obstruents with the dark type, and (3) labials with the fairy type. These sound symbolic effects arguably have their roots in the phonetic properties of the sounds at issue, and are hence not expected to be specific to Japanese. The current study thus tested these sound symbolic associations with English speakers. Two experiments show that they can reliably make these three sound symbolic connections, similar to Japanese speakers. These results support the hypothesis advanced by Shih et al. (2019) that those attributes that are important for survival are actively signaled by sound symbolism.

Keywords: Sound symbolism, English, Pokémon types, sibilants, voiced obstruents, [p]

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*Acknowledgements to be added. The data files for the experimental results as well as the R syntax files are available as supplemental materials.

1 Introduction

1.1 Theoretical background

One of the most influential dictums that governed modern linguistic theories in the twentieth centry was the thesis of arbitrariness—the relationships between sounds and meanings are essentially arbitrary (Hockett 1959; Locke 1689; Saussure 1916/1972). An increasing number of studies, however, have shown that cases of systematic relationships between sounds and meanings are ubiquitous in human languages, and as such the thesis of arbitrariness was too strong. Such sound-meaning associations are now actively studied under the rubric of *sound symbolism*, which is a topic of extensive exploration in linguistics, psychology, cognitive science, marketing research, and related disciplines (see Akita 2015; Dingemanse et al. 2015; Imai & Kita 2014; Kawahara to appear; Lockwood & Dingemanse 2015; Nuckolls 1999; Perniss et al. 2010; Schmidtke et al. 2014; Sidhu & Pexman 2018; Svantesson 2017 for recent reviews). This body of research has shown that sound symbolism may guide first and second language acquisition to a non-trivial degree (Imai & Kita 2014; Nygaard et al. 2009), that it may have played an essential role in the origin and development of human languages (Cabrera 2012; Perlman & Lupyan 2018; Perniss & Vigiliocco 2014), and that it may have neurological bases (Asano et al. 2015; Ramachandran & Hubbard 2001). Research on sound symbolism has moreover shown that these sound-meaning connections may be a specific instance of more general synthetic cross-modal perception, in which sensation in one modality can evoke sensation in another modality (Bankieris & Simner 2015; Cuskley & Kirby 2013; Ramachandran & Hubbard 2001; Spence 2011). While sound symbolism did not use to be a major topic of exploration in linguistics, for the reasons briefly outlined here, there is no doubt that it deserves special attention from the perspectives of (psycho)linguistics and cognitive science.

On the one hand, languages are systems which can connect sounds and meanings in an arbitrary fashion; otherwise, we would expect all the languages to use the same/similar words to express the same meanings (Locke 1689; Saussure 1916/1972), and that languages would not have the immense expressive powers that they do (Lupyan & Winter 2018). At the same time, however, we are witnessing the accumulating body of evidence that speakers of various languages can systematically associate certain meanings with certain types of sounds. These studies have shown, we believe, that whether sound-meaning connections are arbitrary or systematic is no longer the right question to ask—instead, the question that should be addressed is how arbitrariness and sound symbolism can coexist in the human language systems, and relatedly, what kinds of semantic properties can be signaled via sound symbolism.

Two well-known semantic dimensions that are involved in sound symbolic associations are size and shape, which have been shown to hold across different languages (e.g. Bremner et al. 2013, Sidhu & Pexman 2018 and Styles & Gawne 2017); for example, [a] is often judged to be larger than [i] (Sapir 1929) by speakers of different languages (Shinohara & Kawahara 2016), and voiceless obstruents tend to be associated with angular shapes, whereas sonorants tend to be associated with round shapes (D'Onofrio 2014; Köhler 1947; Ramachandran & Hubbard 2001). There are other semantic properties which have been shown to be signaled via sound symbolism, including color, brightness, taste, weight, strength, etc (e.g. Jakobson 1978; Kawahara & Kumagai to appear; Lockwood & Dingemanse 2015; Winter et al. 2019, among others), but it remains to be explored precisely what kinds of semantic concepts can be signaled via sound symbolism in natural languages, and relatedly, how complex such concepts can be (Lupyan & Winter 2018; Westbury et al. 2018).

Within this ever-growing body of studies on sound symbolism, one emerging research strategy is to explore the sound symbolic nature of natural languages using Pokémon names (Kawahara et al. 2018), a research paradigm that is now dubbed "Pokémonastics" (Shih et al. 2019). As discussed in detail by Shih et al. (2019), this research has several distinct virtues. First, since there are many Pokémon characters ($N > 800$) which all have numerical attributes such as weight and height, it allows researchers to conduct a quantitative assessment of sound symbolism in real words. Second, perhaps more importantly in the present context, in natural languages, different languages assign names to a different set of real world attributes; for example, Japanese lexically distinguishes live rice (=*ine*), cooked rice (=*gohan*), and generic rice (=*kome*), a tripartite distinction that is absent in English. This cross-linguistic difference makes it difficult to compare the sound symbolic patterns in existing words in different languages (although it is not impossible: see e.g. Blasi et al. 2016 and Wichmann et al. 2010). On the other hand, in the Pokémon world, the set of denotations is fixed across all languages, thereby making the cross-linguistic comparison easier. The third advantage of the Pokémonastics research is that each Pokémon character has various attributes, such as weight, height, evolution levels, strengths and types. This feature allows researchers to explore what sorts of information can be expressed via sound symbolism (Kawahara & Kumagai to appear).

Within the framework of Pokémonastics research, this paper zooms in on Pokémon types with the hope that it will (albeit modestly) contribute to the general issue addressed in the sound symbolism research discussed above. In the Pokémon game series, players collect fictional creatures called Pokémon, train them, and have them fight with other Pokémon characters. Pokémon characters are classified into several types, including, but not limited to, normal, fire, fairy, water, dragon, ghost, ground, grass, etc.

Hosokawa et al. (2018) report the first study to examine if Pokémon types are symbolically expressed in the Japanese Pokémon names. They found that labial consonants, such [p] and [m], are overrepresented in the names of the fairy type Pokémons, whereas voiced obstruents, such as [d] and [z], are overrepresented in the villainous types. Kawahara & Kumagai (2019b) confirmed the productivity of these associations by an experimental study using nonce words. Extending on these two studies, Kawahara et al. (2020) further found that Japanese speakers associate the flying type with names containing voiceless sibilants, including [s] and [ɕ] (= voiceless alveo-palatal fricative). As discussed in further detail below, these connections are arguably grounded in the phonetic properties of these sounds, and as such they are not expected to be specific to Japanese. The current experiments therefore aim to test the cross-linguistic robustness of these sound symbolic connections targeting English speakers.

As discussed above, the Pokémonastics research can potentially provide a useful resource for cross-linguistic comparisons of sound symbolism in natural languages. While Japanese is actively studied via experimentation within the Pokémonastics paradigm (e.g. Kawahara & Kumagai 2019a,b, to appear; Kawahara et al. 2020; Kumagai & Kawahara 2019), we are yet to gather more data from other languages in order to more thoroughly address the cross-linguistic similarities and differences of sound symbolism. Kawahara & Moore (to appear) and Godoy et al. (2019) have gathered experimental data regarding sound symbolism signaling evolution status in English and Brazilian Portuguese, respectively, but experimental studies on languages other than Japanese are limited to these two studies so far, although Shih et al. 2019 offer an extensive cross-linguistic study of existing Pokémon names in Cantonese, English, Japanese, Korean, Mandarin and Russian. It is thus hoped that the current experiments further contribute to expanding the Pokémonastics database, which should be useful for general sound symbolism research.

1.2 The three sound symbolic connections

The three sound symbolic connections tested in this study are: (1) sibilants = flying, (2) voiced obstruents = dark, and (3) [p] (as a representative of labial consonants) = fairy. In this subsection we expand on each of these sound symbolic associations.

1.2.1 Sibilants = flying

The investigation of the first sound symbolic association, sibilants = flying, was inspired by the remarks by two Ancient philosophers. First, Socrates suggested that [s] and [z] in Classical Greek are suited for words that represent wind and vibration, because the production of these sounds accompanies strong breath (Cratylus: 427). Second, the Upanishads suggested that sibilants represent air and sky. To reinterpret these remarks from the perspective of modern phonetics, sibilants (including [s] and [ʃ] in English) involve a large amount of oral airflow during their production (Mielke 2011), and this aspect of these sounds may be iconically mapped onto the image of wind, and, by extension, flying.

Kawahara et al. (2020) presented Japanese speakers with pairs of nonce words in which one member contained sibilants and the other did not (e.g. [saɾoɕɕuu] vs. [taɾokkuu]), and asked them to judge which member of the pairs was better suited for the flying type Pokémon. Their results suggest that Japanese speakers associate nonce names containing sibilants with the flying type above the chance level. One aim of the current study is to examine whether English speakers make the same sound symbolic association.

1.2.2 Voiced obstruents = dark

The second association was first identified as an existing sound symbolic pattern in the Japanese Pokémon lexicon by Hosokawa et al. (2018). Prior to their studies, it was already known that Japanese monster names and villainous characters' names frequently contain voiced obstruents (=[b], [d], [g], and [z]) (Kawahara 2017; Kawahara & Monou 2017). Building on these observations, Hosokawa et al. (2018) show that voiced obstruents are overrepresented in villainous Pokémon characters, where they defined "villainous" as including dark, ghost and poison types.

In general, voiced obstruents are associated with negative images in Japanese (Hamano 1998; Kawahara 2017; Kubozono 1999; Suzuki 1962), and arguably this sound symbolic connection may have its roots in the articulatory difficulty of producing voiced obstruents (Ohala 1983). In order to maintain vocal fold vibration, the airpressure level has to be lower in the oral cavity than in the subglottal cavity. However, airflow that is required to cause vocal fold vibration is trapped in the oral cavity due to obstruent closure/constriction, which raises the intraoral airpressure. This results in difficulty in maintaining vocal fold vibration, and speakers need to resort to various articulatory adjustments to expand their oral cavity in order to produce voiced obstruents (Ohala 1983; Proctor et al. 2010; Westbury & Keating 1986). Because of this articulatory challenge, many languages phonologically avoid voiced obstruents in favor of voiceless obstruents (Hayes 1999; Hayes & Steriade 2004). It would not be too surprising if this articulatory challenge is projected onto general negative images (Kawahara 2017).

In fact, this association between voiced obstruents and negativity manifests itself in English, as well as in Japanese. Shinohara & Kawahara (2009) presented pairs of pictures of the same object, one in its clean state and the other in its dirty state (e.g. a clean sponge and a dirty sponge). Along with these pictures, they presented nonce words containing voiced obstruents and those containing voiceless obstruents (e.g. [sape] vs. [zabe]). Their results showed that both Japanese and English speakers tend to associate nonce words containing voiced obstruents with dirty pictures. More directly relevant to the current experiments is the finding that in English Disney characters names, villains' names are more likely to contain voiced obstruents than non-villains' names (Hosokawa et al. 2018).

Building on these observations, the current study tests whether English speakers associate voiced obstruents with villainous characters in the Pokémon world, taking the dark type as a representative of villains. We used dark type as the representative, because the dark type literally means the "evil" type (=*aku*) in the original Pokémon series in Japanese.

1.2.3 [p] = fairy

The third hypothesis, like the second hypothesis, was also first identified by Hosokawa et al. (2018) as one of the statistically reliable tendencies in the Japanese Pokémon names. The general observation that lies behind the hypothesis was that labial consonants, including [p] and [m], are generally associated with the image of babies, as evidenced by the fact, for example, that labial consonants are overrepresented in baby diaper names in Japanese, both in the set of existing names and in the new names elicited via experimentation (Kumagai & Kawahara 2017, 2020). Labial consonants are also shown to be overrepresented in the names of PreCure girls—a TV series that is popular among young girls in Japan—who are cute fighters (Kawahara 2019). Along the same line with these studies, Hosokawa et al. (2018) show that bilabial consonants are overrepresented in the fairy type Pokémon characters, which tend to be, like babies and PreCure girls, cute. This association found by Hosokawa et al. (2018) was shown to be productive by a follow-up nonce-word experiment (Kawahara & Kumagai 2019b).

This sound symbolic association is hypothesized to arise from the observation that labial consonants appear frequently in early speech and babbling (Jakobson 1941; MacNeilage et al. 1997; Ota 2015). The current study thus addresses the question of whether, like Japanese speakers, English speakers also associate labial consonants with cute, fairy characters.[1] The current study used [p] as a representative of labials, because it is the consonant that has been judged to be outstandingly cute (Kumagai 2019).

2 Experiment 1

To recap, the current experiment tested three sound symbolic associations that have been shown to hold for Japanese speakers: (1) sibilants = flying, (2) voiced obstruents = dark, and (3) [p] = fairy. In addition to testing these patterns, we also examined a task effect by conducting two experiments: in the first experiment, the stimuli were presented in isolation, whereas in the other experiment, the stimuli were presented in pairs.

Many experiments on sound symbolism tend to present the stimuli in pairs. For instance, the classic experimental study on sound symbolism, Sapir (1929), presented two nonce words (*mal* vs. *mil*) and asked the participants which one means “a big table” and which one means “a small table.” In establishing the *bouba-kiki* effect, Ramachandran & Hubbard (2001) presented the two stimuli (*bouba* and *kiki*) in a pair, and asked which one corresponds to a round figure and which one corresponds to an angular figure. The same holds for Köhler (1947), i.e. *takete* vs. *maluma*. This format has been the common practice in sound symbolic research, but it leaves one important question unanswered (Westbury et al. 2018). To take Sapir’s study for example, is [i] small no matter what, or is [i] smaller than [a]? In other words, are sound symbolic connections comparative or can they hold in isolation? Generally speaking, in such experimentation, the task would be easier for the participants if the stimuli are presented in pairs than in isolation,[2] but would we observe sound symbolic associations under question even when the stimuli are presented in isolation?

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[1] A previous Pokémonastics experiment has shown that given pairs of nonce words containing labial consonants and those containing coronal consonants (e.g. *Meepen* vs. *Neeten*), English speakers tend to choose the former for pre-evolution characters than for post-evolution characters (Kawahara & Moore to appear).

[2] In fact, in Signal Detection Theory, a quantitive measure of sensitivity (“d-prime”) is adjusted by $\sqrt{2}$ when the stimuli are presented in pairs in a 2 alternative forced choice format (Macmillan & Creelman 2005).

2.1 Methods

2.1.1 The stimuli

The list of stimuli used in this experiment is shown in Table 1. For all the pairs, the target consonants appeared twice within each stimulus. The vowels and other target consonants were controlled between the two conditions.

Table 1: The list of stimuli used in Experiment 1.

(a) Names with sibilants	(b) Control
Silshin	Tiltin
Salshim	Taltim
Sulshur	Tulkur
Shieshen	Kieten
Shilsum	Kiltun
Shalshick	Kaltick
Shelshim	Kelkim
(c) Names with voiced obstruents	(d) Control
Bringlin	Prinklin
Branzlam	Pranslam
Drinzlin	Trinslin
Dramblum	Tramplum
Grimblin	Krimplin
Grenzlin	Krenslin
Zegdum	Sektum
Zumgul	Sumkul
(e) Names with [p]	(f) Control
Peepol	Teetol
Polpen	Tolken
Pafpil	Tastil
Pimpock	Tintock
Paapair	Kaakair
Pupmir	Kukmir
Pepmil	Kekmil

For the sibilant condition, the target words contained two sibilants. There were 3 items that started with [s] and 4 items that started with [ʃ] (“sh”), but all of them had [ʃ] internally, because word-internal orthographic ‘s’ in English can be read as [z]. We focused on voiceless sibilants in this study because voiced sibilants can be produced as approximants, as the intraoral airpressure cannot be raised too much to maintain vocal fold vibration, so as not to result in intense frication noise (Ohala 1983). The control condition had 3 items that started with [t] and 4 items that started with [k]. While the stimulus items were not directly paired in Experiment 1, [s] was matched with [t] and [ʃ] was matched with [k], because articulatorily speaking, [t] and [s] are front consonants, whereas [ʃ] and [k] are back consonants (Kingston et al. 2011; Mann & Repp 1981).

For the voiced obstruent condition, the target items began with either [b], [d], [g], or [z] (2 items each), and contained one or more word-internal voiced obstruents. The control condition consisted of words that contain corresponding voiceless obstruents. For the last condition, the target words started with [p] and contained an additional word-internal [p]. The control consisted of words that contain either [t] or [k].[3]

Since Pokémon names are often communicated in written forms, and since the previous Pokémonastics experiments used orthographic stimuli, the current experiment followed that methodology (Kawahara & Kumagai 2019a; Kawahara & Moore to appear). Yet, an experiment with auditory stimuli may be warranted in future studies given the possible influences of orthography on sound symbolism (Cuskley et al. 2017). We note, however, Sidorov et al. (2016) have demonstrated that sound symbolism holds beyond the influences of orthography. With this caveat in mind, the participants were nevertheless asked to read each name silently in their head before making their decision.

2.1.2 Procedure

The experiment was administered online using SurveyMonkey. The first page of the experiment was a consent form, which was approved by the first author's institute. The second page presented our qualification questions, and only those who fulfilled all four of the following conditions were allowed to proceed: (1) they are a native speaker of English, (2) they are familiar with Pokémon,

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[3] The fact that the first and third hypotheses had 7×2 items whereas the second hypothesis had 8×2 items is due to the fact that SurveyMonkey maximally allows 50 questions in order for us to use the buy response function (see §2.1.3 below). It was necessary to include the consent form and the qualification questions, which made it impossible to have 8×2 items for all the three hypotheses.

(3) they are not already familiar with sound symbolism, (4) and they have not participated in a Poémonastics experiment before.

The entire experiment was blocked into three sections, each of which tested one sound symbolic effect on type, in the order of flying type, dark type, and fairy type. The first page within each section introduced a difference between one type of Pokémon, which was contrasted with a normal type of Pokémon, using a pair of pictures shown in Figure 1. The participants were asked to answer whether they understood the difference between the two types. The flying types were defined as those that fly in the sky. The dark types were defined as those that are villainous and evil. The fairy types were those that were cute.

Each name was presented in isolation, and the participants were asked to choose for which type each name is better.. They were also told that there are no “right” or “wrong” answers, and to answer with their intuitive feelings. The order of the stimuli within each block was randomized per participant.

2.1.3 The participants

The responses were collected using the buy response function of SurveyMonkey. A total of 159 Enlgish speakers participated in the experiment. Eleven of them were excluded based on the exclusion criteria listed in §2.1.2. Thirteen participants were excluded because they responded that one or more difference in type was not clear. The data from the remaining 135 participants were analyzed. Among them, 56 of them were male, with one not reporting their gender. All the participants resided in the United States at the time of the experiment.

2.1.4 Analysis

To statistically analyze the data, a logistic linear mixed effects model was fit (Jaeger 2008). The dependent variable was whether or not the response was the target type (flying, dark and fairy). The fixed dependent variable was the phonological difference that is of interest. Both items and participants were included as random variables. We interpreted the models with maximum random

normal Pokémon

flying Pokémon

normal Pokémon

dark Pokémon

normal Pokémon

fairy Pokémon

Figure 1: Pictures used to illustrate each type of Pokémon in the current experiment. These are non-existing Pokémon characters drawn by a digital artist *toto-mame*. They are used in the experiment with the permission from the artist.

structure for all three comparisons (Barr et al. 2013; Barr 2013).

2.2 Results

Figure 2 is a boxplot that shows the by-participant distribution of "flying response" ratios for those names with sibilants and those names without. Here and throughout the rest of the paper, the white circles represent the grand averages, and the grey bars around the circles represent their 95% confidence intervals. On average, the names with sibilants were more likely to be judged to be the names of the flying type than the were control names (54.2% vs. 39.4%), and this difference was statistically significant ($\beta = 0.76, s.e. = 0.21, z = 3.68, p < .001$).

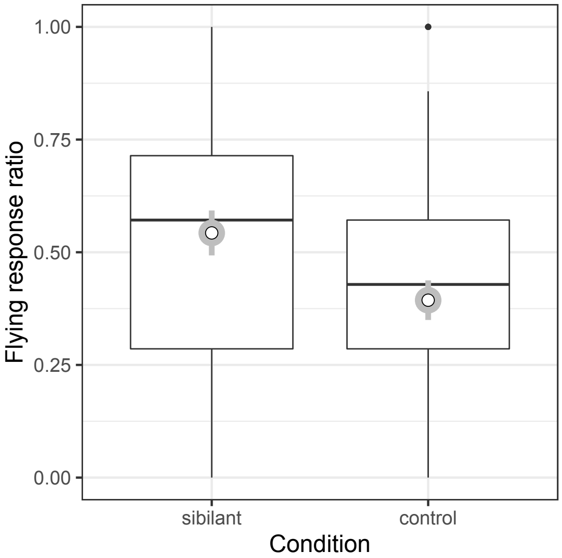

Figure 2: The by-participant distribution of “flying response” ratios. The white circles represent the grand means. The grey bars around the means represent their 95% confidence intervals.

Figure 3 shows the distribution of the “dark response” ratios. Names with voiced obstruents were more likely to be associated with the dark type Pokémon characters than the control names with voiceless obstruents (63.6% vs. 50%). This difference between the two types of names was statistically significant ($\beta = 0.56, s.e. = 0.11, z = 5.18, p < .001$).

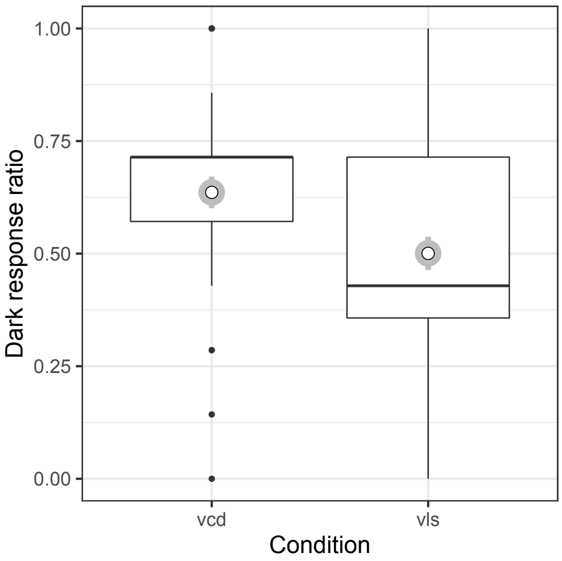

Figure 3: The by-participant distribution of the “dark response” ratios.

Figure 4 shows the distribution of the “fairy response” ratios. The names with [p] were more likely to be associated with the fairy type than the control names (55.1% vs. 47%), although this difference was not statistically significant ($\beta = 0.42, s.e. = 0.26, z = 1.6, n.s.$).

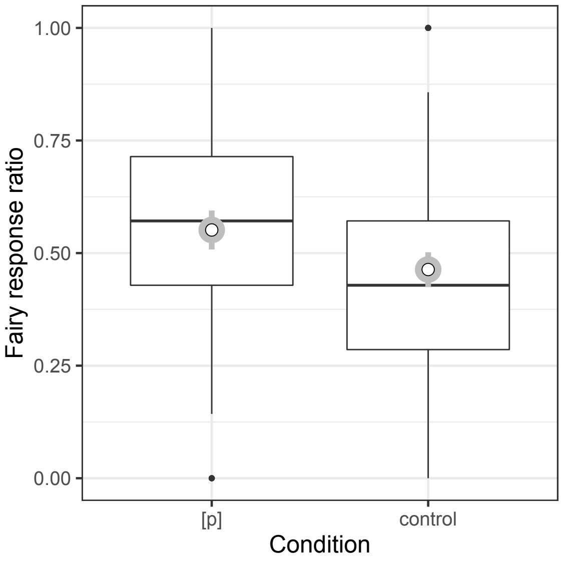

Figure 4: The by-participant distribution of the “fairy response” ratios.

2.3 Discussion

All the comparisons showed responses in the expected direction, and the first two associations (sibilants = flying and voiced obstruents = dark) were statistically reliable. The third hypothesis ([p] = fairy) did not show a statistically significant difference. For the first two associations, we can conclude that English speakers make these sound symbolic associations, like Japanese speakers, and they do so even when the stimuli are presented in isolation. Generally speaking, it shows that sound symbolic effects are not necessary comparative (Westbury et al. 2018).

There are two possible interpretations regarding why we did not identify a statistically significant association between [p] and the fairy type Pokémons in the current experiment. One is simply that English speakers do not make this sound symbolic association at all. We hesitate to accept this interpretation because the responses were in the expected direction, and the by-participants 95% confidence intervals barely overlap in Figure 4.

An alternative explanation is that we did not observe a statistically significant difference because of some task effects. First of all, as stated above, it is more challenging for the participants to make a judgment when stimuli are presented in isolation than in pairs—this is one crucial difference between Kawahara & Kumagai (2019b), who found a robust effect with Japanese speakers, and the current experiment. Relatedly, it is possible that since the stimuli are presented in isolation, the participants' responses were influenced by other segments that are contained in the stimuli. For example, *Polpen* was judged to be more likely to be the normal type than the fairy type, despite the fact that it contains two [p]s. This may be because the initial vowel [o] is the "large" vowel in English (Newman 1933), and hence may have been judged to be inappropriate for the fairy type. Likewise, *Tintok* was judged to be the fairy type almost as frequently as the normal type, which may be because of its initial [i], which is the "small" vowel in English (Newman 1933). In order to tease apart the two possibilities—truly null effects vs. task effects—the next experiment presented the stimuli in pairs.

3 Experiment 2

3.1 Methods

The methods for Experiment 2 were almost identical to those for Experiment 1, unless otherwise noted. Table 2 lists the stimulus pairs used in Experiment 2. Most of the stimuli were the same as those used in Experiment 1, except that the first and the third conditions contained additional test items. In this experiment, all the conditions had 8 pairs.

Table 2: The list of stimuli used in Experiment 2.

(a) Sibilants = flying
Silshin vs. Tiltin
Salshim vs. Taltim
Sulshur vs. Tulkur
Surshum vs. Turkum
Shieshen vs. Kieten
Shilsun vs. Kiltun
Shalshick vs. Kaltick
Shelshim vs. Kelkim
(b) Voiced obstruents = dark
Bringlin vs. Prinklin
Branzlam vs. Pranslam
Drinzlin vs. Trinslin
Dramblum vs. Tramplum
Grimblin vs. Krimplin
Grenzlin vs. Krenslin
Zegdum vs. Sektum
Zumgul vs. Sumkul
(c) [p] = fairy
Peepol vs. Teetol
Polpen vs. Tolken
Pafpil vs. Tastil
Pimpock vs. Tintock
Paapair vs. Kaakair
Pupmir vs. Kukmir
Pepmil vs. Kekmil
Parpil vs. Karkil

As in Experiment 1, the responses were collected using the buy response function in SurveyMonkey. A total of 157 native speakers of English participated in the experiment. Thirteen of them were excluded because they did not fulfill all the participation requirements (see §2.1.2). One participant did not finish the experiment. Eight were not sure about at least one of the three type differences. The data from the remaining 135 participants entered into the following analysis. Among them 66 were male. One of the exclusion criteria ensured no overlap between the participants for Experiment 1 and those for Experiment 2.

The procedure for the experiment was identical to that of Experiment 1, except that the stimuli were presented in pairs. As in Experiment 1, the participants were asked to read the stimuli and use their auditory impression to make their responses.

To statistically analyze the results, we followed the methodology proposed by Daland et al. (2011), which has advantages over other possible alternatives (see their footnote 5)—this is also the methodology often used in the other Pokémonastics experiments when analyzing data obtained using a similar format. Specifically, one trial was split into two observations, each corresponding to one member of a stimulus pair. A logistic linear mixed effects model was fit with the sound symbolic principle as a fixed factor and participant and item as random factors (Jaeger 2008). A model with maximum random structure with both slopes and intercepts was interpreted (Barr 2013; Barr et al. 2013).

3.2 Results

Figure 5 shows the distribution of expected response ratios for each condition, where "expected" means (1) sibilants =flying, (2) voiced obstruents = dark, (3) [p] = fairy. The averages are all above the chance level (flying: 0.57; dark 0.70; fairy: 0.69), and the effects of each sound symbolic principle are all significant (flying: $\beta = 1.18, s.e. = 0.56, z = 2.10, p < .05$; dark: $\beta = 2.56, s.e. = 0.42, z = 6.01, p < .001$; fairy: $\beta = 2.72, s.e. = 0.47, z = 5.85, p < .001$).

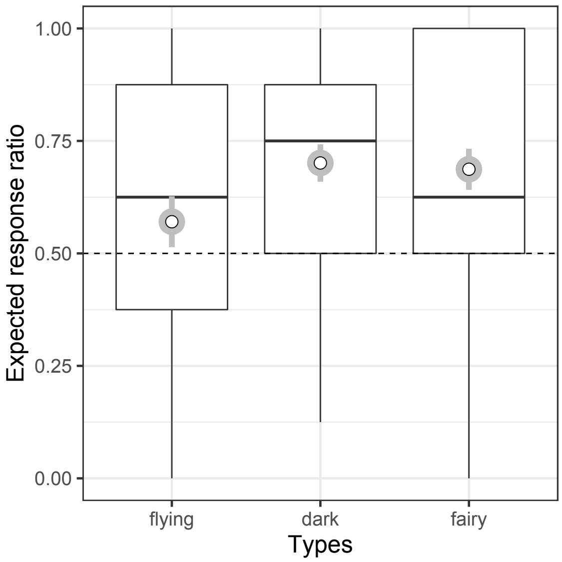

Figure 5: The by-participant distribution of "expected response" ratios for each condition.

3.3 Discussion

Experiment 2 has confirmed the productivity of the two sound symbolic associations (sibilants = flying type and voiced obstruents = dark type), which showed a statistically reliable effect in Experiment 1. The current experiment also showed that when the stimuli are presented in pairs, we observe a reliable connection between [p] and the fairy type. Based on these observations, we conclude that English speakers make similar sound symbolic connections between certain classes of sounds and certain types of characters in Pokémon games, just as Japanese speakers do.

3.4 Inference from the existing patterns

One question that arises from these experimental results is whether these sound symbolic patterns hold in the existing set of English Pokémon names, or whether English speakers could infer Pokémon types based on their tacit knowledge about sound symbolism in the experiments. To address this question, we examined the dataset created by Shih et al. (2019), which includes all the data about English Pokémon names up to the 7th generation (total $N = 802$).[4]

Table 3 shows the distribution of names containing sibilants in the flying type and normal type; contrary to our experimental results, names containing sibilants were in fact more common for the normal type than for the flying type, although this difference was not significant ($\chi^2(1) = 1.22, n.s.$).

Table 3: The distributions of names containing voiceless sibilants in the flying type and normal type in the existing English Pokémon names.

	Flying type	Normal type
contain sibilants	19 (19%)	29 (26.4%)
contain no sibilants	81	81
total	100	110

Table 4 shows the distribution of names containing voiced obstruents in the dark Pokémons and normal Pokémons. It shows that voiced obstruents are slightly more overrepresented in the dark Pokémons, but this difference was not significant ($\chi^2(1) = 1.29, n.s.$).

Table 4: The distributions of names containing voiced obstruents in the dark type and normal type.

	Dark type	Normal type
contain voiced obstruents	28 (59.6%)	53 (48.2%)
contain no voiced obstruents	19	57
total	47	110

Finally, Table 5 shows the distribution of names containing [p] in the fairy type and normal type, which shows that [p] is, contrary to the experimental results, more common in the normal type. This difference is not statistically significant, however ($\chi^2(1) = 0.62, n.s.$).

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[4] We are grateful to Stephanie Shih and her colleagues for letting us use the database. Due to the data sharing agreements, this dataset cannot be publicly made available.

Table 5: The distributions of names containing [p] in the fairy type and normal type.

	Fairy type	Normal type
contain [p]	9 (19.1%)	26 (23.6%)
contain no [p]	38	84
total	47	110

Overall, none of the sound symbolic effects are visible in the existing English Pokémon names. This result points to an interesting difference between English and Japanese, as recall that Hosokawa et al. (2018) showed that two of the three sound symbolic patterns under question hold in the existing Pokémon names in Japanese. (The connection between sibilants and the flying type is not observed in the existing Japanese names: Kawahara et al. 2020.) The reason why the existing English names do not exhibit these sound symbolic connections may be because Pokémon characters were created and named in Japan first, and they were translated into English using real words to describe those characters; for instance, *hitokage*, a small lizard-like character which blows fire, is named *Charmander*, based on *charcoal* and *salamander*. After all, for many words, sound-meaning associations are arbitrary (Hockett 1959; Saussure 1916/1972); therefore, together with the semantic restrictions imposed during the translation process, the English names may have ended up not being very sound symbolic (although see Shih et al. 2019 who show that some sound symbolic effects are observable in the existing English Pokémon names).[5]

Nevertheless we find it interesting that when English speakers are given nonce words with appropriate phonological properties, they are able to make the same sound-symbolic associations that Japanese speakers do. The overall results therefore support the thesis that arbitrariness and sound symbolic connections can co-reside within a single language system, or put differently, just because existing words are arbitrary, it does not mean that speakers do not have intuitions about possible

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[5] Another difference between Japanese and English is that Japanese has a rich set of ideophonic expressions, which are more sound symbolic than prosaic words (Akita 2019; Akita & Dingemanse 2019). Some Pokémon names in Japanese are based on such ideophonic expressions. For instance, *pii*, a small fairy Pokémon, may be named after *pii-pii*, an ideophonic expression mimicking a chick's chirp.

sound-symbolic connections. This situation reminds us of recent phonological studies which show that despite the lack of evidence in the lexicon, certain phonological patterns grounded in phonetic considerations—just like the sound symbolic patterns that we investigated in this paper—can be observed in experimental setting using new words (Guilherme 2019; Jarosz 2017; Wilson 2006).

4 Conclusion

We started with a general question regarding sound symbolic effects in natural languages: what kinds of semantic properties can be signaled via sound symbolism, and how complex can these properties be? The current experiments have shown that notions as complex as Pokémon types can be symbolically represented. We find this result intriguing as they show that sound symbolism is not limited to simple semantic notions such as size and shape.

We also find it encouraging that those sound symbolic associations that are tested in the experiments have plausible bases in the phonetic and/or phonological properties of the sounds at issue. To recap, sibilants involve large amounts of oral airflow during their production which is required to cause frication (Mielke 2011), and this phonetic property may be iconically mapped onto the notion of wind, and by extension, flying. Voiced obstruents are associated with general negative images, because of their articulatory challenge (Ohala 1983). Labial consonants, particularly [p], are associated with the image of cuteness, because those are the typical sounds that are produced by babies (Jakobson 1941). It would not be surprising if such sound symbolic patterns, which are grounded in phonetics, are shared across different languages. We do not intend to pretend that testing these effects in just two languages—Japanese and English—suffices to establish the universality of sound symbolism, yet the current findings offers a good start for future cross-linguistic investigations.

Having established that English speakers too can infer Pokémon types from sound symbolism, we would like to end this paper by briefly discussing what Shih et al. (2019) conclude based on an extensive cross-linguistic comparison of Pokémon names. In the real world, we observe various types of sound symbolic effects to signal gender differences (Sidhu & Pexman 2019); for instance, male names are more likely to contain obstruents than female names (*Eric* vs. *Erin*: Cassidy et al. 1999). On the other hand, we do not observe robust sound symbolic effects to signal gender differences in the Pokémon world. This difference between the real world and the Poémon world arises maybe because finding a mate is crucial for survival and reproduction in the real world, but not so much in the Pokémon world. This hypothesis is further supported by the fact that Pokémon strength status is sound symbolically signaled across languages, together with the fact that Pokémon characters fight with each other; i.e., Pokémon strengths are important for their survival.

Thus, sound symbolism may be actively deployed to signal those attributes that are important for their survival in that world. Types play a non-trivial role in Pokémon battles (e.g. fairy type has advantages over dark type), and therefore, it is predicted that types constitute an attribute that should be signaled by sound symbolism. While the current study lends further support to this idea, it also raises a few new questions. One is whether types other than flying, dark, and fairy can be symbolically represented. Another is whether the sound symbolic patterns tested in the current study also hold for speakers of languages other than English and Japanese. More generally, can we observe sound symbolic effects for any properties crucial for survival and reproduction in the real world? These questions can be tested via future experimentation.

All in all, the current experiments have shown that English speakers can associate certain types of sounds with certain Pokémon types, and they do so similar to Japanese speakers. This parallel may not come as too much of a surprise, to the extent that the sound-meaning associations are grounded in phonetic and phonological properties of the sounds at issue. We also find it encouraging that sound symbolic effects—at least some of them—were identifiable in an experiment in which the stimuli were presented in isolation rather than in pairs, showing the general robustness of sound symbolic effects. Finally, the fact that the sound symbolic associations are not observed in the existing English Pokémon names but yet can be identified by English participants with nonce words shows that arbitrariness and sound symbolism can co-exist within a single system.

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