The sound symbolism of size and speed in Japanese vehicle and Pokémon character names

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1. Introduction

The link between sound and meaning in natural languages has been traditionally held to be wholly arbitrary (Saussure, 1916). There are, however, exceptions to this general principle which have become the focus of much recent research (e.g., Hinton et al., 2006; Fort et al., 2015; Blasi et al., 2016; Kawahara, 2017; Westbury et al., 2018; Shih & Rudin, 2020). These cases of *sound symbolism,* in which certain phonological properties are associated with semantic properties, appear to involve connections made by speakers between the physical properties of a sound and the meanings of words containing that sound.

Two sound-meaning correspondences have emerged in the literature as being robustly correlated with physical size: vowel height and obstruent voicing. Low vowels tend to occur in words referring to large objects, with high vowels being more frequent in words for smaller objects (Sapir, 1929; Ultan, 1978). In addition to being instantiated in corpora of existing words, this association has also been shown to influence subjects' decisions in nonce-word experiments (Shinohara & Kawahara, 2010). This correspondence has been suggested to derive from the physical facts of vowel articulation—the production of low vowels involve a greater jaw opening than that of high vowels, resulting in a larger vocal cavity (Kawahara et al., 2014). Speakers, so this argument goes, are subconsciously aware of this size difference in their own vocal tract, and thus learn to associate lower vowels with greater physical size, an association which presumably influences the process of word creation.

A similar link has also been found between voiced obstruents and the semantics of size. Shinohara & Kawahara (2010) found that speakers of Chinese, English, and Japanese rated nonwords containing voiced obstruents as referring to larger objects than nonwords with voiceless obstruents. As with vowel height, here too a physiological cause has been suggested for this correspondence. By its nature, voicing requires continuous airflow through the glottis—obstruents, however, because they utilize constrictions in the vocal tract, impede this airflow. The solution to this conundrum involves expanding the vocal tract (for example by puffing out the cheeks) in order to maintain the airflow necessary for voicing (Ohala, 1983). This vocal tract expansion is associated by speakers with large size, just as with the greater jaw opening used to produce low vowels.

These associations between the state of the articulators during the production of a given sound and the meanings of words containing that sound suggest that other such associations might be possible. The tap [ɾ], for example, is characterized by a rapid movement of the tongue tip to the alveolar ridge, resulting in a closure averaging 20 ms (Ladefoged and Maddieson, 1996). The stops [t] and [d], which in English involve essentially the same tongue gesture as the tap, typically have durations on the order of 50 ms (Crystal & House, 1988). The tap, then, involves a much more rapid movement of the articulators, a difference which is noticeable if one pronounces [ada] and [aɾa] in succession. This raises the possibility that, just as low vowels and voiced obstruents are associated with size, the tap might be associated with speed. On this theory, names for things known for their rapidity will tend to contain more taps than other words.

As Kawahara et al. (2018) point out, this proposal was made originally by Socrates, who claimed that the Greek letter ρ, realized in Ancient Greek as either a trill or a tap, "appeared to be a fine instrument expressive of motion to the name-giver who wished to imitate rapidity"（Plato, *Cratylus,* Fowler translation）. As examples Socrates offers a number of motion-related words such as ῥεῖν（'flow'）, ῥοή（'current'）, and ῥυμβεῖν（'whirl'）. He makes explicit the link between meaning and articulator movement, arguing that "the tongue is least at rest and most agitated in pronouncing this letter."

In this paper, I test this hypothesis using two sets of words: the names of various models of automobile, and（following Kawahara et al., 2018）the names of characters in the Pokémon video game[1]. I utilize data from Japanese, because unlike in English, where the tap is an allophone of /t/ and /d/ which is not reflected in the orthography, in Japanese［ɾ］is the unique realization of the phoneme /r/, making it possible to identify taps directly from data written in the kana orthography. Both automobile and Pokémon names have the advantage of being largely invented out of whole cloth, rather than being constructed by combining pre-existing morphemes. This gives the creator of the name greater freedom in choosing a name purely based on its sound, making it more likely that sound symbolic associations will exert a greater influence.

Using this data, I examine both the previously established size symbolisms involving vowel height and obstruent voicing, as well as the possible relationship between taps and speed. More specifically, I test four hypotheses:（1）larger car names will contain on average more low vowels than smaller cars,（2）larger car names will contain more voiced obstruents than names of smaller cars,（3）names of sports cars will contain more taps than names of other car types, and（4）names of faster Pokémon will contain more taps than names of slower Pokémon. In the next two sections, I describe each study in turn.

2. Study 1: Automobile model names

2.1. Data gathering and processing

The raw data was taken from motor-fan.jp, a website specializing in providing information on vehicles available in Japan. From this site I downloaded a list of car model names[2] produced by Japanese companies for the domestic market[3]. The site provides information on the body type[4] and passenger capacity for each car, which I included in the data. This resulted in a list of 712 model names.

Because the raw data was written in Japanese orthography, I converted each name to a phonemic IPA representation of the pronunciation. Because some names included alphabetic letters, these were rendered using their standard pronunciation in Japanese（e.g., "SMX" became［esɯ emɯ ekkɯsɯ］）, with the following exceptions: "BOX" was rendered as［bokkɯsɯ］, "MAX" as［makkɯsɯ］, "WiLL" as［wiɾɯ］, and "RAV" as［ɾabɯ］, based on information from each manufacturer's website. In addition, the plus symbol（"＋"）was rendered as［pɯɾasɯ］, following the standard Japanese pronunciation. The Greek letter alpha（"α"）was rendered as［aɾɯɸa］, and theta（"θ"）as［ʃiːta］. Due to uncertainty as to the pronunciation of numerals, they were removed from the names except in cases where I was able to determine how the name is pronounced by Japanese speakers. This led to a number of duplicate names, which were removed from the data. One name which consisted exclusively of numbers was also removed, resulting in a final total of 687 names.

2.2. Data analysis

Because the original data did not include information on the size or weight of the vehicles, I decided to use passenger capacity as a proxy for size. Because the majority（55%）of the automobiles in the data are five-passenger vehicles, it was impossible to divide them into three equal groups. I thus divided the data into three categories in the following way: *small,* vehicles accommodating fewer than five passengers（N＝203）, *medium*, those which accommodate exactly five passengers（N＝390）, and *large,* those which hold more than five passengers（N＝118）. I then analyzed the ratios of voiced obstruents to voiceless obstruents and high vowels to low vowels in each of the three categories.

In order to analyze the correlation between vehicle speed and the presence of taps, I divided the data into sports cars（N＝43）, as determined by the motor-fan.jp website, and all other body types（N＝668）. The question then arises as to how to calculate the numbers of taps in each vehicle type. Merely comparing numbers of taps per name would introduce name length as a confound. Computing the number of taps per name as a ratio is the obvious solution, but what to use as the denominator? The number of taps as a proportion of all consonants in the name is one possibility, but differences in the proportions of obstruents and sonorants have been found to have sound symbolic effects in previous studies (Shinohara & Kawahara, 2013), which could introduce another confound—if, for example, sports car names use fewer sonorants than other car types, this would distort the ratio of taps to other consonants. I therefore use the proportion of taps to other non-tap sonorants as the dependent variable in this study.

2.3. Results

For each of the oppositions under study (voiced versus voiceless obstruents, high versus low vowels, tap versus other sonorants), I pooled the total number of segments in each category, resulting in 2x2 tables like the following.

	Voiced	Voiceless
Large	148	203
Small	140	410

I then performed a one-tailed Fisher's Exact Test on each table to test for significance.

I begin with the obstruent voicing results. Note that in the graphs below I include the medium size category for illustrative purposes, but it was not included in the statistical analyses.

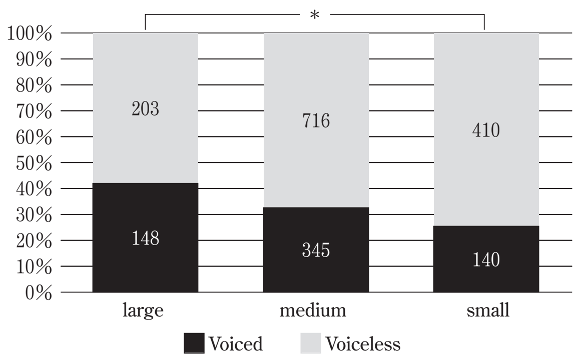

Figure 1. Proportions of voiced and voiceless obstruents by vehicle size. Numerals indicate numbers of vowels in each category.

Figure 1 shows the obstruent proportions for each vehicle size class. The Fisher's Exact Test performed on the large and small categories reveals that a significantly greater ($p < 0.0001$) proportion of voiced obstruents occur in large vehicle names (42.2%) than in small vehicle names (25.5%). This is consistent with the prediction, supported by previous literature, that voiced obstruents are associated with size and power, and that this association influences the creation of automobile brand names.

I turn next to the vowel height results, shown in Figure 2.

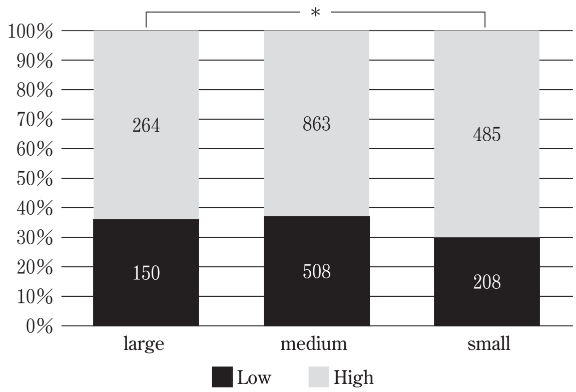

Figure 2. Proportions of high and low vowels by vehicle size. Numerals indicate numbers of vowels in each category.

A greater proportion of the total number of low vowels (36.2%) occur in the names of large vehicles than occur in the names of small vehicles (30.0%). This pairwise difference is also significant ($p = 0.0193$). Again, this result is consistent with previous findings that low vowels correlate with greater size.

The results thus far are essentially replications of previous work, albeit with a novel data set. The next result, involving the relationship between taps and speed, represents a hypothesis original to this research (*pace* Socrates).

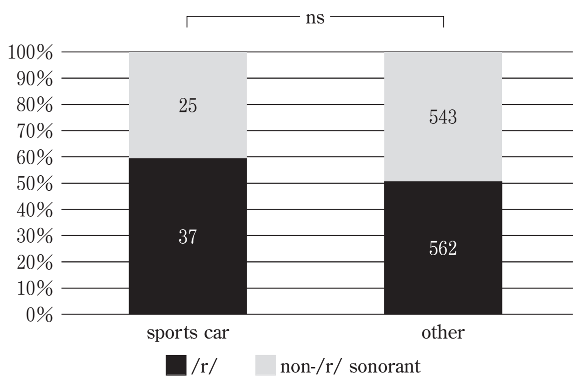

Figure 3. Proportion of taps to non-tap sonorants by automobile type. Numerals indicate numbers of sonorants in each category.

As can be seen in Figure 3, although there was a difference found in the predicted direction between the proportion of taps in sports cars (59.7%) and in other vehicle types (50.9%), the difference was not significant ($p=0.111$).

There are a number of ways to interpret this lack of difference. It may simply be an artifact of the small number of sports cars in the data. It may also be the case that although the tap is indeed associated with speed, automobile manufacturers use the sound in names of *all* types of vehicle, not only sports cars. In the interests of marketing, perhaps even slower cars are given an image of speed. This hypothesis could be tested by comparing the proportion of taps in car names overall to the names of some other type of product, which has no particular relationship to speed.

Another possibility is suggested by Kawahara et al.'s (2013) finding that sound symbolic patterns are stronger in word-initial syllables (see also Haynie et al., 2014). It may be that, although overall differences in the numbers of taps do not reach significance, a stronger effect would be found if the analysis were restricted to the initial consonant of each name. Unfortunately, with the present data set the number of sports car names is too small (a total of 41 names, with only seven being sonorant-initial) to support this type of analysis. In the next section, I turn to a data set consisting of Pokémon names, which will allow us to explore this possibility.

3. Study 2: Pokémon names

3.1. Data gathering and processing

The data used in this study consisted of a list of characters ("Pokémon") used in the game *Pokémon Sword and Shield.* Characters in the name are all assigned a number of statistics, or "stats", which determine their effectiveness in combat with other characters. These stats include such things as Health Points, Attack, Defense, and Speed. A high Speed allows the character to attack quickly, before a slower enemy has a chance to attack. I downloaded a list of the characters used in the game, along with their respective Speed stats, from the website gamewith.jp[5]. The names were written in katakana characters, and were converted into a phonemic IPA representation in the same way as the car names in Study 1. There are a total of 405 names in the data set.

3.2. Data analysis

As in Study 1, 2x2 grids (fast/slow versus tap/non-tap sonorant), in which each cell consisted of a number of segments, were tabulated from the data. One-tailed Fisher's Exact Tests were used to determine the significance of each cross-category difference.

3.3. Results

I first examined the total numbers of taps and non-tap sonorants used in the Pokémon names. In order to test the sound symbolism hypothesis, I ranked the list of names by Speed score, and then divided it into faster and slower halves. Because there was an odd number of names, and due to the fact that many characters have identical scores, dividing the list precisely in half was impossible. The closest feasible division was into a *fast* group of 201 characters, with Speed scores ranging from 157 to 561, and a *slow* group of 204 characters, with scores ranging from 62 to 156.

The results of the first analysis are displayed in Figure 4.

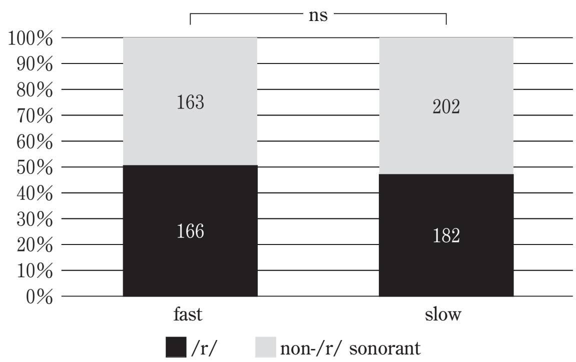

Figure 4. Proportion of taps to non-tap sonorants by Pokémon speed. Numerals indicate numbers of sonorants in each category.

Although there is a slight difference in the proportion of taps in the predicted direction (50.5% for fast versus 47.4% for slow), it is not significant ($p=0.228$). As with vehicle names, it is not possible to rule out the null hypothesis that there is no effect of character speed on the phonological properties of that character's name. However, unlike the previous study, there are a sufficient number of sonorant-initial names to permit testing of the subsidiary hypothesis that sound symbolic effects are stronger in the prosodically prominent initial syllable.

I therefore conducted a second analysis, in which only word-initial sonorants were counted (vowel- and obstruent-initial names were thus excluded). The results are presented in Figure 5.

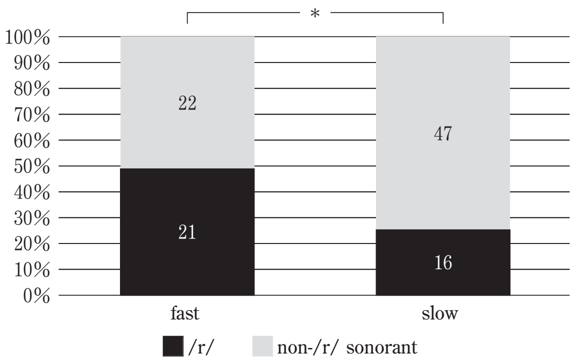

Figure 5. Proportion of name-initial taps to non-tap sonorants by Pokémon speed. Numerals indicate numbers of names in each category.

The difference is clearly more prominent for word-initial segments—48.8% of sonorant-initial names in the fast group begin with a tap, compared to only 25.4% for the slow group. This time, the difference is significant ($p = 0.012$). This suggests that, at least for Japanese speakers, taps are indeed associated with rapid movement.

4. Discussion and conclusion

This study used two data sets consisting of Japanese automobile model names and Pokémon names to test four hypotheses regarding sound symbolism. The first two involve size—both voiced obstruents and low vowels were predicted to be overrepresented in the names of larger vehicles. This hypothesis was confirmed—vehicles with a capacity of between six and ten passengers had names witch contained a greater proportion of low vowels and voiced obstruents than those with a capacity of between one and four passengers. This adds further support to previous findings of similar correlations in other types of name (Sapir, 1929; Kim, 1977; Ultan, 1978; Shinohara & Kawahara, 2010; Haynie et al., 2014; Shih et al., 2018).

The second set of hypotheses involves the relationship between taps and the semantic property of speed. Here, the results were less clear. Names of sports cars displayed a non-significant trend towards containing more taps than other car types. There was no significant difference between the names of fast and slow Pokémon. A significant difference did emerge, however, when the analysis was restricted to the initial consonants of the Pokémon names.

Although it is too early to declare that Japanese speakers definitely associate the sound /r/ with rapid movement, this potential example of sound symbolism clearly warrants more study. Possible avenues for future research include examinations of larger, more diverse data sets, as well as experimental studies involving nonce words which could more directly probe native speaker intuitions. Another possibility would be to expand the research to include languages which use alveolar trills, sounds whose rapid tongue movement may provoke a stronger connection with the idea of speed.

Notes

1) The *Pokémon* video game was first created by Nintendo in 1995, with many subsequent versions. The data in this paper are taken from Pokémon Sword and Pokémon Shield, a pair of role-playing games developed in 2019 for the Nintendo Switch.
2) Only the model names were used—the "Honda Accord", for example, was listed as "Accord" (アコード in Japanese).
3) The data is accessible at https://motor-fan.jp/catalog/country/10. The page was accessed on October 27, 2020.
4) The website categorizes all car models into the following body types: sedan, hard top, convertible, sports car, hatchback, compact car (軽自動車), station wagon, minivan, SUV, light RV, and pickup truck.
5) The name list can be found at https://gamewith.jp/pokemon-sword-shield/article/show/178692, and was accessed on November 13, 2020.

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