EXPRESS[P] in expressive phonology: analysis of a nicknaming pattern using ‘princess’ in Japanese

Abstract

Recent studies have shown that sound-symbolic patterns can be modelled using phonological theory. The purpose of the current study is to describe a new Japanese nicknaming pattern, *pime-yobi*, wherein [h] alternates with [p] to express cuteness, and to model it using maximum entropy harmonic grammar. The current study, building on the analysis of Alderete & Kochetov (2017), proposes a sound-symbolic EXPRESS[P] constraint that requires output forms to contain [p]. The results of two experiments show that the sound-symbolic effect of [p] associated with the image of cuteness is present in a cumulative manner, and the *pime-yobi* nicknaming exhibits intra- and inter-speaker variation in terms of acceptability and cuteness. Based on these results, the current theoretical analysis shows that the EXPRESS[P] constraint displays counting cumulativity, and the weight of this constraint varies both across different speakers and with the same speaker.

1. Introduction

1.1 Sound symbolism in phonology

Two contrasting relationships are exhibited between sounds and meanings in natural language. On the one hand, the association between sounds and meanings is arbitrary (de Saussure 1916, Hockett 1963), such that, for example, the sequence of sounds /tʃɛː/ has nothing to indicate that it refers to ‘a piece of furniture with four legs, for sitting’ (*chair*) in English. However, a growing body of research in linguistics, psychology, and cognitive science has shown that sounds are associated with particular images and meanings; this phenomenon is generally referred to as iconicity or sound symbolism (for an overview, see Hinton *et al*. 1994/2006, Perniss *et al*. 2010, Schmidtke *et al*. 2014, Dingemanse *et al*. 2015, Lockwood & Dingemanse 2015, Sidhu & Pexman 2018, Nielsen & Dingemanse 2021; *inter alia*). A widely observed sound-symbolic association is that [a] is associated with the image of largeness and [i] is associated with the image of smallness (Sapir 1929, Newman 1933, Taylor & Taylor 1965, Peña *et al*. 2011, Shinohara & Kawahara 2016). The ‘[a]=large/[i]=small’ association is arguably rooted in the articulatory gesture where the oral aperture of low vowels is open wider than that of high vowels (Sapir 1929). This association is also motivated by the frequency code hypothesis that low-frequency sounds in the second formant are associated with the image of largeness, whereas high-frequency sounds are associated with the image of smallness (Ohala 1984, 1994).

The recent review articles cited above show that sound symbolism has been actively examined in various language science fields. However, Alderete & Kochetov (2017: 731) have noted, “… it is fair to say that sound symbolism has never found a natural place in generative grammar”; this means that few studies in phonology research have analysed sound-symbolic effects (see Kawahara 2020b, 2020c for a detailed discussion). Against this background, recent works have shown that sound-symbolic effects can be analysed using phonological theory. For example, Alderete & Kochetov (2017) proposed expressive/iconic constraints, EXPRESS(X), to account for the non-assimilatory palatalisation found in baby-talk registers or diminutives (e.g. in Japanese, /sakana/ ‘fish’ → /[tɕ]akana/; /dʑuːsu/ ‘juice’ → /dʑuː[tɕ]u/), which shows different features from assimilatory palatalisation. Moreover, by using a constraint-based theory—Optimality

Theory (OT) (Prince & Smolensky 1993/2004, McCarthy 2002, 2008)—Alderete & Kochetov (2017) showed that the constraint is ranked higher in the case where such a non-assimilatory palatalisation occurs. In addition, numerous studies (Kawahara *et al*. 2019, Jang 2020, Kawahara 2020a, 2020b, 2021, Shih 2020) have shown that sound-symbolic patterns can be modelled using maximum entropy harmonic grammar (Maxent HG) (e.g. Goldwater & Johnson 2003, Jäger 2007, Hayes & Wilson 2008), which is a type of stochastic version of HG (for HG, see Legendre *et al*. 1990, 2006, Pater 2009, 2016, Potts *et al*. 2010). These studies suggest that sound symbolism has successfully contributed to the development of phonological theory.

1.2 Purposes of the current study

The purpose of the current study is to describe a Japanese nicknaming pattern (called *pime-yobi* 'princess-calling'), wherein [p] (voiceless bilabial plosive) is used to express cuteness. Moreover, the current study models this nicknaming pattern by using Maxent HG. The reason for adopting HG, rather than OT, is that the newly proposed constraint in the current study (see Section 2.4) shows counting cumulativity: multiple violations of a lower-weighted constraint overcome a higher-weighted constraint (Jäger & Rosenbach 2006). Counting cumulativity differentiates HG from OT. In HG, many violations of even low-weighted constraints can be fatal when determining the optimal candidate, whereas in OT, it is not fatal for a candidate to incur many violations of low-ranked constraints.

The reason for adopting a stochastic version of HG, rather than a non-stochastic version, is that it is suitable for analysing the gradient acceptability of output variants.[1] In the earlier days of generative linguistics, phonology was assumed to be categorical, but a growing body of research in recent years has shown that phonological knowledge, which includes phonotactics and (some) morphophonological processes, is gradient rather than categorical (e.g. Frisch *et al*. 2000, Ernestus & Baayen 2004, Hayes & Londe 2006, Daland *et al*. 2011). The current study conducted acceptability and cuteness judgement tasks, thereby showing that the variants of the *pime-yobi* nicknaming exhibit gradient acceptability (i.e. not dichotomous between 'acceptable/cute' and 'unacceptable/not cute'). Another reason for using stochastic HG is harmonic bounding, a case where no matter how constraints are ordered, one form is never chosen as the winner (see Prince & Smolensky 1993/2004: 168). Among the *pime-yobi* nicknaming variations is one that has never been observed in real life (see Section 2.3), and theoretically, this variant is harmonically bounded by another (i.e. it is never selected as a winner). However, the current experiment shows that the harmonically bounded variant is chosen by some speakers. Maxent HG can model this pattern because it assigns a probability to each output form that includes harmonically bounded candidates (Jäger & Rosenbach 2006).

This study explores the '[p]=cuteness' association in Japanese. There is evidence that [p] is associated with the image of cuteness. First, studies have reported that bilabial consonants are used in cute character names for video games ('Pokémon') or animation ('PreCure') (Kawahara 2019,

[1] Another stochastic version of HG is known as Noisy HG, which has been discussed in recent literature (e.g. Boersma & Hayes 2016, Hayes 2017, Hayes & Zuraw 2017, Flemming 2021). The current study does not offer an analysis using Noisy HG, but this does not imply that Maxent HG is more suitable than Noisy HG for modelling the nicknaming pattern. Future research should conduct a comparison with the two models.

Kawahara & Kumagai 2019a) and in baby product names (Kawahara 2017, Kumagai & Kawahara 2020, Hirabara & Kumagai 2021). Therefore, bilabial consonants may be associated with an image of cuteness. This association may be derived from the cross-linguistic observation that bilabial consonants are produced in the earlier stage of children's development (Jakobson 1941/1968, MacNeilage *et al*. 1997; see Ota 2015 for data from Japanese-speaking children), and may also be derived from the pouting gesture with both lips, called 'duck-face', which is said to be sexually enticing (Kumagai 2020). Additional evidence of the '[p]=cuteness' association is Kumagai's (2019) experimental demonstration that singleton [p] is the consonant more likely to be associated with the image of cuteness, compared with other consonants in Japanese, which can be motivated by the frequency code hypothesis according to which high-frequency consonants (i.e. voiceless obstruents) are associated with the image of smallness (Ohala 1984, 1994).

The remainder of this paper is organised as follows. Section 2 describes the new Japanese nicknaming pattern to express cuteness and proposes a new sound-symbolic EXPRESS constraint. Section 3 (Experiment 1) examines whether the more [p]s a nonce word contains, the more likely the image of cuteness is to be boosted and discusses whether the EXPRESS constraint shows a cumulative effect. Section 4 (Experiment 2) conducts two judgement tasks to examine how Japanese speakers perceive certain variants of the new nicknaming pattern. Based on the results of the two experiments, Section 5 models the Japanese *pime-yobi* nicknaming using Maxent HG, thereby showing that the weight of the EXPRESS constraint varies both across different speakers and within the same speaker.

2. Analysis for the nicknaming pattern, *pime-yobi*

2.1 The distribution of [p] or [pp] in Japanese

The current section briefly details the distribution of singleton [p] or geminated [pp] in Japanese. This language has six plosives: [p, t, k, b, d, g]. Among these plosives, the voiceless bilabial plosive [p] exhibits different behaviours in several aspects. First, this plosive is notably less frequent than the others (see Labrune 2012, chap.3.15). Second, the distribution differs across Japanese lexical strata (Yamato [native] words, Sino-Japanese words, foreign words, and mimetic words; see Itô & Mester 1995, 1999, Nasu 2015). As shown in (1a), there is no distributional restriction of [p] in foreign words (e.g. Itô & Mester 1995: 819, Labrune 2012: 61). As in (1b), mimetic words like reduplicated forms /$C_1VC_2VC_1VC_2V$/ allow singleton [p] to occur in the stem-initial (C_1) position (see Nasu 2015: 261).

(1) a. Foreign words
paaku 'park'; purin 'pudding'; sapooto 'support'; ai-paddo 'i-Pad'; shiroppu 'syrup'

b. Reduplicated forms in mimetic words
puka-puka 'floating'; pata-pata 'flapping'; pon-pon 'belly (child language)'

Meanwhile, the distribution of singleton [p] is restricted in Yamato words and Sino-Japanese words. This is allowed to occur only in the stem-initial position of the second member of the compounds, as exemplified in (2).[2] In Yamato words, [p] generally appears as an alternant of [h],

[2] For the sake of explanation, we here assume the replacement of [h] with [p]. There is an

and it almost always becomes geminated [pp], as in (2a) (Labrune 2012: 60). In Sino-Japanese compounding, [h] alternates with [p], becoming geminated [pp] (e.g. *syuppatsu* ‘departure’), or [h] turns into [p] after a moraic nasal (e.g. *kanpou* ‘Chinese medicine’) (Labrune 2012: 61). Yamato words and Sino-Japanese words rarely begin with singleton [p] (e.g. *hadaka* ‘naked’ → **padaka*; *hara* ‘belly’ → **para*; *hatsugen*‘remarks’ → **patsugen*; *hougaku* ‘direction’ → **pougaku*), although a few exceptions are found in slang (e.g. *peten* ‘trickery’; *pakuru* ‘to filch’, Labrune 2012: 72).

(2) a. Yamato (native) words

su	‘bare’	+	hadaka	‘naked’	→	su**pp**adaka	cf. *padaka
yoko	‘side’	+	hara	‘belly’	→	yoko**pp**ara	cf. *para

b. Sino-Japanese words

	syutsu	出	+	hatsu	発	→	syu**pp**atsu	‘departure’ 出発
	kan	漢	+	hou	方	→	kan**p**ou	‘Chinese medicine’ 漢方
cf.	hatsu	発	+	gen	言	→	hatsugen/ *patsugen	‘remarks’ 発言
	hou	方	+	gaku	角	→	hougaku/ *pougaku	‘direction’ 方角

2.2 A sound-symbolic [h]→[p] alternation

This section discusses a Japanese nicknaming pattern wherein [h] alternates with [p], as exemplified in (3) (Kumagai 2019, 2022). Example (3a), *Paruru*, is the nickname for *Haruka (Shimazaki)*, an ex-member of the Japanese girls’ idol group *AKB48*. In this nickname, the initial consonant [h] becomes [p], and the second mora [ru] is reduplicated. This type of reduplication is often observed in Japanese girls’ idol names (see Hashimoto 2016, Kawahara *et al*. 2019 for other examples). Example (3b), *Miporin*, is the nickname for the Japanese actress and singer, *Miho (Nakayama)*. Attaching a suffix-like nonce word *rin* is another nicknaming pattern found in Japanese (e.g. *Mari* (personal name) + *rin* → *Maririn*; *Yosi* (personal name) + *rin* → *Yosirin*) that is not always specific to female nicknaming. Example (3c), *Ripopo*, is the nickname for *Riho (Miaki)*, an ex-member of another Japanese idol group, *Yoshimotozaka46*. In this nickname, [h] turns into [p], and [po] is reduplicated. The [h]→[p] alternation in (3) is often used for (cute) female names; thus, it is termed a sound-symbolic [h]→[p] alternation in the current study, which is considered an output-output operation, often found in truncation, between the output of the base form and the output of the nicknaming form (e.g. McCarthy & Prince 1995, Benua 1997 for output-output correspondence).

(3) Female nicknames showing [h]→[p] alternation

a. Haruka (female name) → Paruru
b. Miho (female name) → Miporin
c. Riho (female name) → Ripopo

alternative assumption that the underlying consonant /p/ alternates with [h] (see, e.g., McCawley 1968, Itô & Mester 1999: 67).

In addition to the examples in (3), we can also find girls' nicknames affixed with a suffix-like morpheme [piː]; for example, the Japanese actress and singer, *Noriko (Sakai)*, is nicknamed *Noripii*, in which the first two moras of her first name are compounded with [piː]. This example shows that, even if the name does not contain [h] that can alternate with [p], it can be made to sound cute by attaching a suffix-like morpheme containing [p]. This process can be termed a sound-symbolic [p]-addition.

There are some interesting characteristics specific to the nicknames in (3). First, singleton [p] occurs in the word-initial position in (3a). In addition, although *Miho* and *Riho* in (3b, 3c) are standard Japanese female first names, the names with [h]→[p] alternation are allowed only in nicknames; to the best of my knowledge, there is no person whose original name is *Mipo* or *Ripo*.

In addition to the sound-symbolic reason of the [h]→[p] alternation, the use of [p] admitted in the nicknaming process is also motivated by functional aspects. As mentioned in the previous section, singleton [p] is a less frequent consonant in native and Sino-Japanese words. For this reason, the name to which the [h]→[p] alternation is applied is unlikely to merge with other existing words in Japanese, thereby causing no functional problems for speakers. Alternatively, the consonant is less frequent in people's real names, thus making it possible to consider singleton [p] as a marker for nicknaming (Kohei Nishimura, p.c.).

2.3 A nicknaming pattern using 'princess', *pime-yobi,* and a challenging issue

The current section describes a Japanese nicknaming pattern, sometimes called *pime-yobi* 'princess-calling'. Recently, blogs and articles on social media written in Japanese have displayed a new kind of nicknaming pattern using the word *hime* 'princess'—as exemplified in (4) (see Appendix 1 for the links to the blogs and articles), wherein the initial consonant [h] becomes [p] when the word is attached after a real name (e.g. *Ayu* (personal name) + *hime* 'princess' → *Ayu-**p**ime* 'Ayu-princess').

(4) Examples of the nicknaming pattern called *pime-yobi*
Ayu-pime; Kana-pime; Manami-pime; Nana-pime; Sakura-pime; Yuka-pime; Yuri-pime

This nicknaming pattern, like the examples in (3), is often found in female names; thus, it may be induced by the sound-symbolic [h]→[p] alternation. However, *pime-yobi* nicknaming causes a theoretical issue; the sequence of labial consonants [p…m] in the nickname would violate the constraint that penalises identical place-of-articulation features (i.e. [labial]) occurring in a specific domain, namely, the Obligatory Contour Principle on place-of-articulation (OCP-Place; McCarthy 1986, 1988). Let us now consider this seemingly challenging issue.

A well-known morphophonological process in Japanese is rendaku, in which the initial voiceless consonant /t, k, s, h/ becomes voiced [d, g, z, b] when it is the second member of a compound, as presented in (5) (Vance 1987, 2015, Vance & Irwin 2016). However, rendaku application is blocked under several conditions. One of the most well-known conditions is that, as exemplified in (6), rendaku does not apply when the second member of the compound already contains a voiced obstruent, which is known as Lyman's Law, or OCP (voice, −sonorant) (Itô & Mester 2003). For example, the second member /tabi/ of the first compound in (6) does not undergo rendaku, because it already contains a voiced [b] before compound formation.

(5) Examples of Japanese rendaku

kusu	‘medicine’	+	tama	‘ball’	→	kusu-dama ‘decorative paper ball’
riku	‘land’	+	kame	‘turtle’	→	riku-game ‘tortoise’
oo	‘big’	+	same	‘shark’	→	oo-zame ‘big shark’
hako	‘box’	+	hune	‘ship’	→	hako-bune ‘ark’

(6) Rendaku blocking by Lyman’s Law

naga	‘long’	+	tabi	‘travel’	→	naga-tabi ‘long trip’, *naga-dabi
hito	‘person’	+	kage	‘shadow’	→	hito-kage ‘silhouette’, *hito-gage
aka	‘red’	+	sabi	‘rust’	→	aka-sabi ‘red rust’, *aka-zabi
tori	‘bird’	+	hada	‘skin’	→	tori-hada ‘gooseflesh’, *tori-bada

Another condition blocking rendaku is that /h/ does not become [b] when the second member of the compound already contains [m] (Kawahara *et al*. 2006, Kawahara 2015). As shown in (7), for example, the word *hime* ‘princess’ does not become **bime*. Kumagai (2017) experimentally examined whether this restriction is attributed to the OCP-labial constraint (i.e., a ban on two consecutive labial consonants) observed in other languages (McCarthy 1988, Selkirk 1993, Odden 1994, Alderete & Frisch 2007, Coetzee & Pater 2008, Zuraw & Lu 2009). The results showed that rendaku application is blocked when the second member of the compound contains consecutive labial consonants [b…b], [b…m], [b…ɸ] (except for [b…w]) after compound formation.

(7) Rendaku blocking in [b…m]

mai	‘dancing’	+	hime	‘princess’	→	mai-hime ‘dancing girl’, *mai-bime
suna	‘sand’	+	hama	‘beach’	→	suna-hama ‘sand beach’, *suna-bama
kutu	‘shoe’	+	himo	‘lace’	→	kutu-himo ‘shoelace’, *kutu-bimo
ma	‘genuine’	+	hamo	‘pike conger’	→	ma-hamo ‘genuine pike conger’, *ma-bamo

Returning to the issue of *pime-yobi* nicknaming, if the sound-symbolic [h]→[p] alternation causes [hime] to become [pime], this output form contains two labial consonants [p…m], thereby violating the OCP-labial constraint. This constraint violation may be a trivial issue because sound-symbolic processes may violate the constraints enforced in native phonology (Alderete & Kochetov 2017). More importantly, however, the [h]→[b] alternation (*[hime]→[bime]) does not appear in *pime-yobi* nicknaming, even though both [pime] and [bime] violate the OCP-labial constraint. Therefore, only the [hime]→[pime] alternation may be induced by another constraint. The current study builds on the analysis of Alderete & Kochetov (2017) and proposes that *pime-yobi* nicknaming is induced by a sound-symbolic constraint, EXPRESS[P], which is described in detail in Section 2.4.

2.4 The EXPRESS[P] constraint

Alderete & Kochetov (2017) proposed EXPRESS constraints that formalise sound-symbolic/iconic aspects of particular sounds in a particular register or lexical stratum. Following this study, Jang (2020) proposed another EXPRESS constraint to account for the strategies observed in a baby-talk register, Korean *Aegyo*, which people use when talking to pets and lovers. The current study proposes a sound-symbolic constraint, EXPRESS[P], which requires output forms to have the following phonological features: [labial], [−continuant], and [high-frequency]. The features [labial] and [−continuant] are motivated by the observation that, in children's phonological development, bilabial stops (especially, [p, b, m]) are acquired earlier (Jakobson 1941/1968, MacNeilage *et al*. 1994). The feature [high-frequency] is motivated by the frequency code hypothesis according to which high-frequency consonants, such as voiceless consonants, are associated with the image of smallness (Ohala 1984, 1994). Only [p] in Japanese satisfies the three phonological features. The EXPRESS[P] constraint is defined in Section 5, where an HG analysis is provided.

As mentioned in Section 1.2, numerous studies have shown that bilabial consonants can convey the image of cuteness, thereby suggesting that the Japanese language shows sound-symbolic effects of other constraints, such as EXPRESS[B], EXPRESS[M], or a more generalised constraint, EXPRESS[LABIAL]. Although this is an interesting hypothesis to be tested, an in-depth discussion is beyond the scope of the current study. Therefore, some possibilities are briefly mentioned below. The bilabial nasal [m] (sonorant) can also be associated with the image of cuteness because sonorants are used more frequently than obstruents in Japanese female first names (Shinohara & Kawahara 2013). However, nasals exhibit a low frequency in the first formant (Reets & Jongman 2009), and are thus less likely to be associated with the image of smallness than [p] (with high frequency). For the same reason, voiced [b] (with low frequency) is also less likely. Moreover, a voiced obstruent [b] exhibits a 'dirty' image (Kawahara *et al*. 2008, Uno *et al*. 2020). A more generalised constraint, EXPRESS[LABIAL], is discussed in Section 6.2.

2.5 Motivation for experiments

To summarise, the current study posits that the sound-symbolic [h]→[p] alternation observed in *pime-yobi* nicknaming is induced by the EXPRESS[P] constraint. Here, some questions arise regarding *pime-yobi* nicknaming and the EXPRESS[P] constraint. One question is regarding whether more [p]s in a nickname indicate a further boost to the image of cuteness. This is a key question that must be addressed in HG analysis, where the counting cumulativity effect of the constraint makes a difference in determining the optimal output form (Jäger & Rosenbach 2006). Numerous studies have addressed the question about whether sound-symbolic effects are present in a cumulative manner (see Kawahara 2020b, Kawahara & Breiss 2021 for a background overview and analysis). For example, English speakers compared nonce words with one to five 'large phonemes', such as back vowels and voiced consonants (= *a, u, o, m, l, w, b, d, g*), and the more 'large phonemes' in a word, the more likely that word was to be associated with a larger size of 'greeble', a novel object used for testing (Thompson & Estes 2011). In Pokémonastics research (Kawahara *et al*. 2018, Shih *et al*. 2019 *et seq*.), the higher the number of moras (two to seven) in a nonce word, the more likely the name was chosen as appropriate for a post-evolved (stronger, heavier, larger) *Pokémon* character name (Kawahara 2020a). Other studies have shown that the cumulative sound-symbolic effect is restricted. For example, a name that contains two voiced obstruents was more appropriate for post-evolved *Pokémon* character names than a name that contained one voiced obstruent, but no difference was noted in the sound-symbolic effect between two and three occurrences (Kumagai & Kawahara 2019; see also Kawahara & Kumagai 2019b, 2021 for the cumulative effect of voiced obstruents in Pokémonastics research). The current study addresses the above question in Section 3 (Experiment 1) by examining whether names that contain one, two, or more [p]s are perceived by Japanese speakers as cuter names and discusses whether the EXPRESS[P] constraint shows the sound-symbolic effect in a cumulative manner.

Another question focuses on intra- and inter-speaker variations in *pime-yobi* nicknaming. The sound-symbolic [h]→[p] alternation is optional, such that not all speakers perceive *pime-yobi* nicknaming as a cute or acceptable name. Therefore, examining how cute or acceptable *pime-yobi* nicknaming sounds across different speakers is a crucial task. The current study addresses this question in Section 4, where Experiment 2 asks Japanese speakers to rate the acceptability and cuteness of three relevant variants regarding *pime-yobi* nicknaming**—***hime* 'princess' (base form), *pime* (*pime-yobi* form) and *bime* (rendaku form).

Variation is one of the most widely discussed topics in linguistics (e.g. Labov 2004, Anttila 2007). In phonology, variation in output forms has been analysed using various OT approaches: partial constraint reranking (Anttila 1997, Anttila & Cho1998), stochastic OT (Boersma 1998, Boersma & Hayes 2001), freely-ranked constraints (Reynolds 1994, Nagy & Reynolds 1997), and ranking candidates (Coetzee 2006). In HG models, variation is captured using stochastic versions of HG, such as Maxent HG and Noisy HG (for Noisy HG, see Boersma & Pater 2016, Hayes 2017, Zuraw & Hayes 2017, Flemming 2021). The current study adopts Maxent HG to model the variants of *pime-yobi* nicknaming, based on the results of Experiments 1 and 2, thereby establishing that the weight of the EXPRESS[P] constraint varies across particular speakers and between two distinct phonologies—expressive and non-expressive phonology (see Section 5).

3. Experiment 1

3.1 Task and stimuli

To examine whether the EXPRESS[P] constraint displays a cumulative sound-symbolic effect, Experiment 1 tested whether the number of singleton [p]s in names affects the image of cuteness. The experiment used a two-alternative forced-choice task, wherein participants were given two nonce words and asked to select the name that they felt was cuter than the other. As shown in Table 1, three conditions compared CV-trimoraic names with one or more [p]s (target stimuli in the right columns) and those without any [p]s. The first condition (Condition 1) contained singleton [p] in the first mora, the second condition (Condition 2) contained two singleton [p]s in the first and second moras, and the third condition (Condition 3) contained three singleton [p]s. The other consonant used in addition to [p] was [ç, ɸ, h], the allophones of /h/ before [i], [u], and [a, e, o], respectively (e.g. Vance 1987, Labrune 2012, Tsujimura 2014). Each condition comprised ten pairs. A total of 30 pairs were presented.

Condition 1			Condition 2			Condition 3		
[haheho]	vs.	[paheho]	[haheho]	vs.	[papeho]	[haheho]	vs.	[papepo]
[hahohe]	vs.	[pahohe]	[hahohe]	vs.	[papohe]	[hahohe]	vs.	[papope]
[çiɸuho]	vs.	[piɸuho]	[çiɸuho]	vs.	[pipuho]	[çiɸuho]	vs.	[pipupo]
[çihoɸu]	vs.	[pihoɸu]	[çihoɸu]	vs.	[pipoɸu]	[çihoɸu]	vs.	[pipopu]
[ɸuhaho]	vs.	[puhaho]	[ɸuhaho]	vs.	[pupaho]	[ɸuhaho]	vs.	[pupapo]
[ɸuhoha]	vs.	[puhoha]	[ɸuhoha]	vs.	[pupoha]	[ɸuhoha]	vs.	[pupopa]
[hehoha]	vs.	[pehoha]	[hehoha]	vs.	[pepoha]	[hehoha]	vs.	[pepopa]
[hehaho]	vs.	[pehaho]	[hehaho]	vs.	[pepaho]	[hehaho]	vs.	[pepapo]
[hoçihe]	vs.	[pohihe]	[hoçihe]	vs.	[popihe]	[hoçihe]	vs.	[popipe]
[hoheçi]	vs.	[poheçi]	[hoheçi]	vs.	[popeçi]	[hoheçi]	vs.	[popepi]

Table 1
The set of stimuli in Experiment 1

3.2 Procedure

The current experiment was implemented online using the buy response function provided by SurveyMonkey, where participants were provided a monetary reward after completing the experiment. Participants were first given a consent form to sign if they agreed to participate and then asked whether they were native Japanese speakers and if they had ever heard of the term ‘sound symbolism’. Only those who were native Japanese speakers and had never heard of the term ‘sound symbolism’ were allowed to participate.

The current experiment used orthographic stimuli using katakana characters, the orthography usually used to represent loanwords in Japanese. The participants were instructed to select which of the two names sounded cuter (‘kawaii’ in Japanese). They were not provided with a definition of cuteness, or *kawaii* in Japanese. They practised one question that asked which of the two names, *ramire* and *remire*, sounded cuter than the other, before answering 30 questions. The orders of two names within each pair and thirty pairs of stimuli were randomised for each participant. After completing all the questions, they were asked about their age and gender.

3.3 Participants

The participants were 100 native Japanese speakers. The experiment included 64 female and 36 male participants. Most participants (*n*=96) were aged between 20 and 39 years (47 speakers between 20 and 29 years old; 49 speakers between 30 and 39 years old). Three were over 50 years old and one was between 18 and 19 years old.

3.4 Statistics

The two-alternative forced-choice task provided a categorical response; thus, a logistic regression model (Winter 2019) was fitted to the experimental results, using the glmer function in the lme4 package (Bates *et al*. 2015) in R (R Core Team 2020). As a response variable, the response for which the target stimulus was judged to be a cute name was coded as ‘1’, and the inverse response was coded as ‘0’. Different participants could show different responses to each stimulus; thus, the model included by-stimulus random intercepts and by-participant random intercepts (Baayen *et al*. 2008). The data files for analysis are available at https://osf.io/pj5qz/. The next section presents the overall results for each condition, with an estimated value of the slope as a logit coefficient (*b*), standard error (*SE*), *z* value, and *p* value. If the slope (*b*) in each condition and the *z* value are greater than zero, this indicates that the stimuli that contained [p] in each condition were judged to be a cuter name.

3.5 Results

Figure 1 shows the rates at which participants selected names with one or more [p]s as the cuter name in each condition. The error bars represent 95% confidence intervals, based on the average rate of each condition. The average rates were 0.795 in the first condition (‘one’), 0.839 in the second condition (‘two’), and 0.835 in the third condition (‘three’). The logistic regression analysis showed that each condition was significantly different from chance level (0.5): Condition 1 (b = 2.711; SE = 0.111; z = 24.47; $p < .001$), Condition 2 (b = 3.302; SE = 0.122; z = 27.13; $p < .001$), and Condition 3 (b = 3.243; SE = 0.121; z = 26.92; $p < .001$). Furthermore, an analysis of inter-condition differences (with the Bonferroni correction that a *p*-value less than 0.0167 is statistically significant) showed significant differences between Conditions 1 and 2 (b = 0.449; SE = 0.169; z = 2.66; $p < .01$) and between Conditions 1 and 3 (b = 0.413; SE = 0.156; z = 2.65; $p < .01$). However, there was no significant difference between Conditions 2 and 3 (b = 0.043; SE = 0.154; z = 0.281; *n.s*).

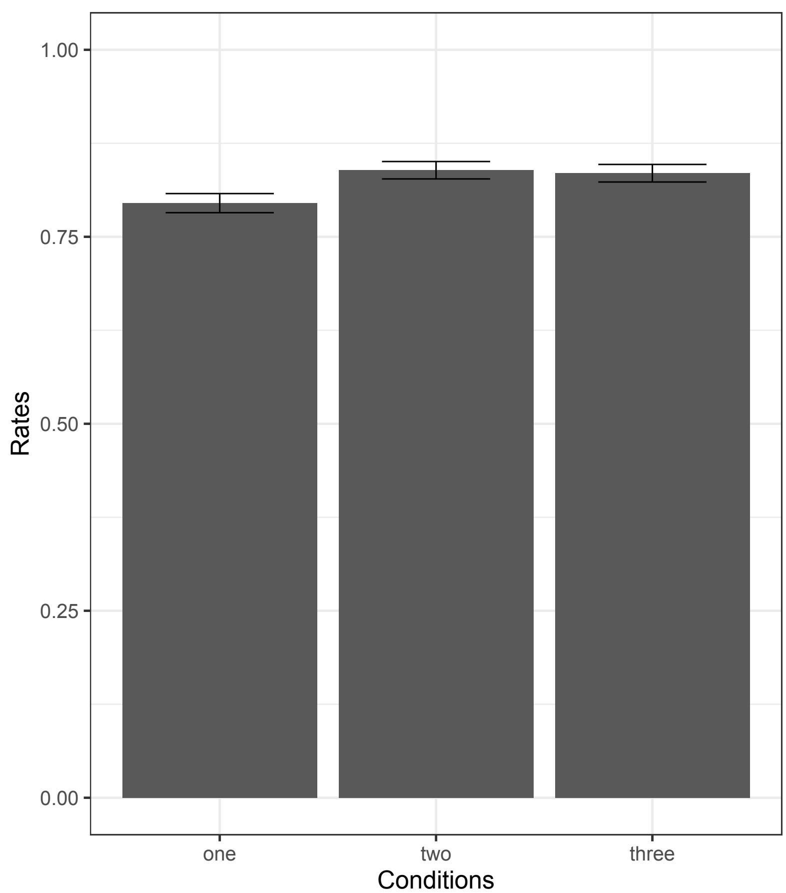

Figure 1

Rates at which names containing one or more [p]s were chosen as a cuter name (*N*=100)

3.6 Discussion

The experiment results show that Japanese speakers judged names with one [p] as a cuter name than those with no [p]. This result is consistent with Kumagai's (2019) results, showing that a singleton [p] was more likely to express cuteness than other consonants in Japanese.

The experiment also showed that names with two [p]s were judged as cuter names than those with one [p], but names with three [p]s were judged to be as cute as those with two [p]s. This result is similar to that of Kumagai & Kawahara (2019), who showed that two occurrences of a voiced obstruent showed a stronger sound-symbolic effect on *Pokémon* character names than one occurrence, whereas no difference was noted between two and three occurrences. A reason for the difference between one and two occurrences may be because, given a particular sound with a phonological feature [X], it is important in Japanese that a word contains one [X] or two [X]s. For instance, there are monomorphemic native words that contain one voiced obstruent (e.g. *huda* 'sign'; *buta* 'pig'), but not those that contain two voiced obstruents (e.g. **buda*) (Itô & Mester 1995). In addition, as shown in (6), Lyman's Law works when the second member of a compound contains two voiced obstruents. In contrast to one vs. two distinctions, however, it is not important that a word contains two [X] or three [X]s, as there seems to be no blocking effect due to three, rather than two, occurrences of [X] in Japanese. This may be why no difference was noted between the two and three occurrences in the current experiment. Building on the Experiment 1 results, Section 5 provides a definition of the EXPRESS[P] constraint.

4. Experiment 2

4.1 Task and stimuli

Experiment 2 examined how Japanese speakers rated acceptability and cuteness for three variants relevant to *pime-yobi* nicknaming: nicknames with *hime* (base form), *pime* (*pime-yobi* form), and *bime* (rendaku form, which is never observed in real life). The stimuli used are listed in Table 2. Participants were provided non-real bimoraic names (N_1), and were then asked to compare 'N_1-pime' with 'N_1-hime' (Condition 1) and 'N_1-bime' with 'N_1-hime' (Condition 2), by using the score criteria shown in Table 3. For each criterion, Score-3 is a baseline, thereby indicating that one nickname sounds as acceptable or cute as the other. For instance, if a participant believed that *yaka-pime* sounded as acceptable as *yaka-hime* in the first pair of Condition 1, they assigned a score of three points. Each condition comprised seven pairs, and a total of 14 pairs were presented.

Condition 1			Condition 2		
X		Y	X		Y
yaka-pime	vs.	yaka-hime	yaka-bime	vs.	yaka-hime
meki-pime	vs.	meki-hime	meki-bime	vs.	meki-hime
rosa-pime	vs.	rosa-hime	rosa-bime	vs.	rosa-hime
mase-pime	vs.	mase-hime	mase-bime	vs.	mase-hime
mani-pime	vs.	mani-hime	mani-bime	vs.	mani-hime
rane-pime	vs.	rane-hime	rane-bime	vs.	rane-hime
yora-pime	vs.	yora-hime	yora-bime	vs.	yora-hime

Table 2

The set of stimuli in Experiment 2

Scores	Acceptability	Cuteness
5	X sounds more acceptable than Y.	X sounds cuter than Y.
4	X sounds slightly more acceptable than Y.	X sounds slightly more cute than Y.
3	X sounds as acceptable as Y.	X sounds as cute as Y.
2	X sounds slightly more unacceptable than Y.	X sounds slightly less cute than Y.
1	X sounds more unacceptable than Y.	X does not sound as cute as Y.

Table 3

Criterion for evaluation of acceptability (left); Criterion for evaluation of cuteness (right)

4.2 Procedure

As in Experiment 1, the current experiment recruited participants using the buy response function in SurveyMonkey and obtained their consent through a consent form. Participants were asked whether they were native Japanese speakers, and if they had ever heard of the terms ‘sound symbolism’ and ‘rendaku’. All participants were native Japanese speakers, and no participant reported that they had ever heard of the terms ‘sound symbolism’ and ‘rendaku’.

Experiment 2, as well as Experiment 1, used katakana characters as the orthographic stimuli. Participants were presented with female nicknames attached to *hime*, *pime*, and *bime*, all of which meant ‘princess’, and were then requested to rate the acceptability and cuteness of each pair based on the criterion in Table 3. In the judgement tasks, the Japanese words *sizen* ‘natural’ and *kawaii* ‘cute’ were used as words that correspond to *acceptable* and *cute* in English, respectively (e.g. X *wa* Y *yorimo sizen-da* = ‘X sounds more acceptable than Y’; X *wa* Y *yorimo kawaii* = ‘X sounds cuter than Y’). As in Experiment 1, the current experiment did not define what is cute, or *kawaii* in Japanese. After practising how to assign scores, they first evaluated acceptability for all 14 pairs and then evaluated the cuteness of all these pairs. All pairs and names within each pair were presented randomly to each participant. After completing the task, participants were asked about their age and gender.

4.3 Participants and grouping for analysis

Experiment 2 recruited 100 native Japanese speakers who were different from those in Experiment 1. Most of these participants were aged between 20 and 39 years (46 speakers between 20 and 29 years old; 48 speakers between 30 and 39 years old), five were over 40 years old, and one was between 18 and 19 years old. A total of 57 speakers were female and 43 were male.

The results of each participant were categorised, based on the average score in Condition 1 (*pime* vs. *hime*) in the cuteness judgement task, into two subgroups. Those whose average score was greater than three points—they judged *pime* as cuter than *hime*—were subcategorised as 'cuteness-sensitive speakers' (*n*=34). The subgroup included 21 female and 13 male participants. Concerning age, 18 speakers were aged between 20 and 29 years, 13 were aged between 30 and 39 years, two were between 40 and 49 years, and one speaker was aged over 60.

In contrast, those who scored less than three points on average for the same condition—they judged *hime* to be cuter than *pime*—were subcategorised as 'cuteness-insensitive speakers' (*n*=50). The subgroup included 20 female and 30 male participants. In terms of age, 21 speakers were aged between 20 and 29 years, 28 speakers were aged between 30 and 39 years, and one speaker was aged between 40 and 49 years.

Categorising cuteness sensitivity by age and gender may yield interesting results. This analysis is, however, left for Appendix 2, because the current results show that the two factors were not associated with a difference in cuteness-sensitivity.

4.4 Statistics

A linear mixed-effects model was fitted to the experimental results using the lmer function in the lme4 package (Bates *et al*. 2015) in R (R Core Team 2020). The response variable was the score (five at the maximum and one at the minimum). Similar to the analysis in Experiment 1, the model included by-stimulus random intercepts and by-participant random intercepts (Baayen *et al*. 2008). The lmer function does not produce *p* values (Baayen *et al*. 2008); thus, *p* values were calculated after installing the lmerTest package (Kuznetsova et al. 2017). The data files for analysis are available at https://osf.io/pj5qz/. The next section reports whether differences were noted between Conditions 1 and 2 for the cuteness-sensitive and cuteness-insensitive speakers, with an estimated value of the slope (*b*), standard error (*SE*), *t* value, and *p* value.

4.5 Results

Figure 2 presents box plots for the results of acceptability and cuteness judgement tasks. Black diamonds represent the average score in each condition (Condition 1 is represented by 'p'; Condition 2 by 'b'). The white boxes represent the interquartile range, thin vertical lines represent the rest of the distribution, black dots represent outliers and black horizontal lines represent the median in each condition.

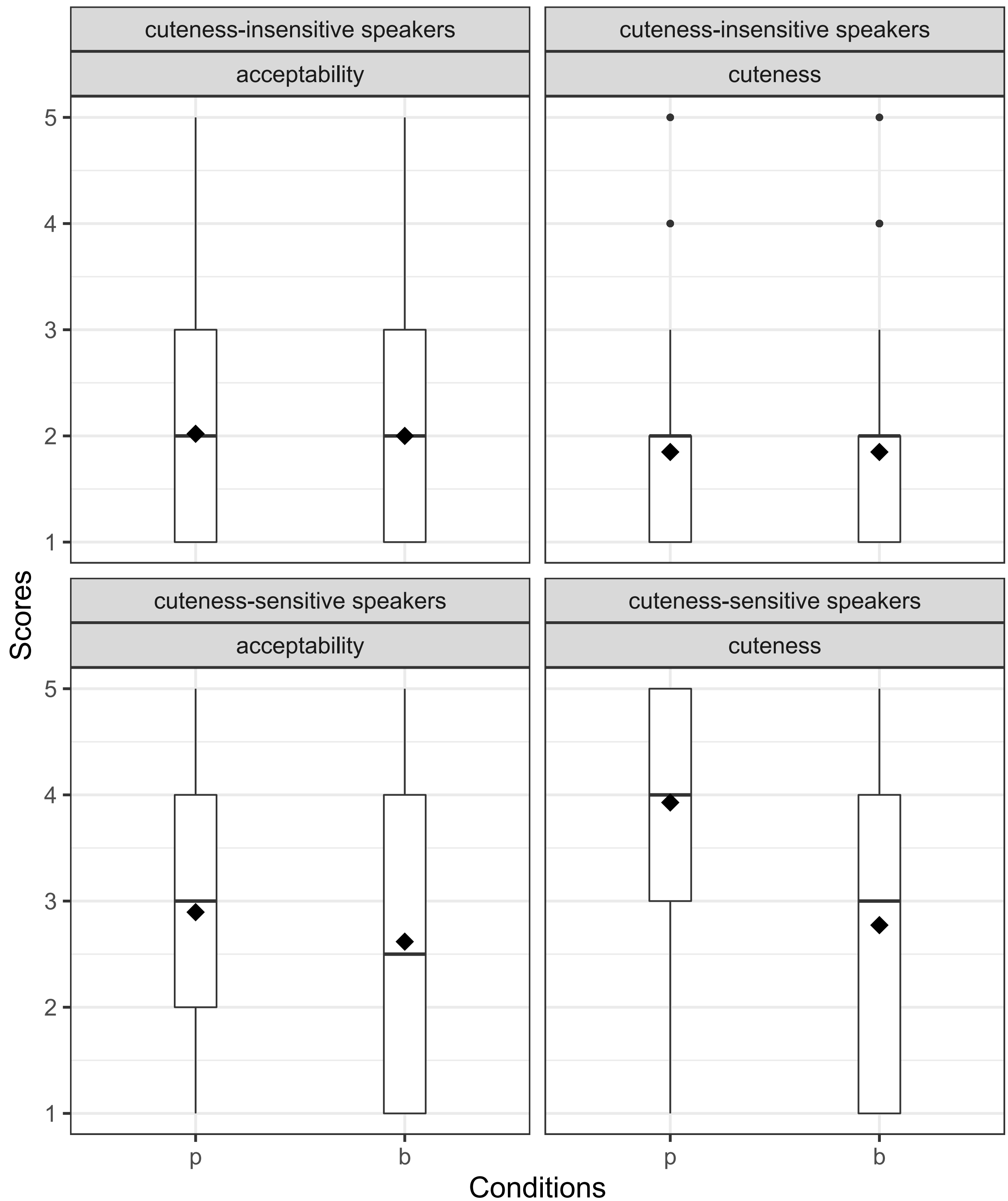

Figure 2

Box plots for acceptability and cuteness judgement tasks (by speaker)

The results of cuteness-sensitive speakers (*n*=34) show that in the acceptability judgement task, the average score was 2.89 in the [p] condition and 2.62 in the [b] condition (see the lower left figure). Moreover, a significant difference was noted between the two conditions (β = 0.276, *SE* = 0.08, *df* = 443, *t* = 3.485, $p < .001$). In the cuteness judgement task, the average score was 3.93 in the [p] condition and 2.77 in the [b] condition (see the lower right figure). Again, a significant difference was noted between them (β = 1.155, *SE* = 0.089, *df* = 441.04, *t* = 13.00, $p < .001$).

The results for cuteness-insensitive speakers (*n*=50) show that in the acceptability judgement task, the score in the [p] condition was 2.02 on average and 2 in the [b] condition (see the upper left figure), and no significant differences were detected between them (β = 0.02, *SE* = 0.056, *df* = 13.1193, *t* = 0.348, *n.s.*). In the cuteness judgement task, both scores in the [p] and [b] conditions were 1.85 on average (see the upper right figure), and no significant differences were noted between them (β = 0.00, *SE* = 0.05251, *df* = 13.14, *t* = 0.00, *n.s.*).

Table 4 shows the distribution of higher scores (Score=5 or 4) and lower scores (Score=2 or 1), with the exception of Score 3. Considering Condition 1 of the lower left figure in Figure 2 (i.e. acceptability for cuteness-sensitive speakers) as an example, there were 89 responses rated for Scores 5 and 4 (i.e. *pime* sounds (slightly) more acceptable than *hime)* and 99 responses rated for Scores 2 and 1 (i.e. *pime* sounds (slightly) more unacceptable than *hime*). The observed probabilities for each were 0.473 and 0.527, respectively. The number of responses in each category presented here are used as input values for the Maxent HG analysis in Section 5.

	speakers	cuteness-sensitive speakers		cuteness-insensitive speakers	
	scores	acceptability	cuteness	acceptability	cuteness
Condition 1	5 ~ 4 (pime > hime)	89 (0.473)	176 (0.9026)	38 (0.134)	13 (0.044)
	2 ~ 1 (hime > pime)	99 (0.527)	19 (0.0974)	245 (0.866)	282 (0.956)
	ALL	188	195	283	295
Condition 2	5 ~ 4 (bime > hime)	67 (0.36)	80 (0.447)	33 (0.115)	31 (0.104)
	2 ~ 1 (hime > bime)	119 (0.64)	99 (0.553)	254 (0.885)	266 (0.896)
	ALL	186	179	287	297

Table 4

The number of responses to higher and lower scores and observed probabilities in cuteness-sensitive and cuteness-insensitive speakers

4.6 Discussion: The order of acceptability and cuteness

Based on the experiment results, the current section discusses the order of acceptability and cuteness of the three variants for cuteness-sensitive and cuteness-insensitive speakers. For cuteness-sensitive speakers, the average scores in the [p] and [b] conditions (i.e. [p]=2.89; [b]=2.62) were less than three points (=baseline) in the acceptability judgement task, although the score in the [p] condition was significantly higher than that in the [b] condition. Therefore, the order of acceptability is *hime* > *pime* > *bime*. However, in the cuteness judgement task for these speakers, the average score in the [p] condition (i.e. [p]=3.93) was above three points (=baseline), and the average score in the [b] condition (i.e. [b]=2.77) was below the baseline, with a significant difference being noted between the two values. Therefore, the order of cuteness is *pime* > *hime* > *bime*. For cuteness-insensitive speakers, the average scores in the [p] and [b] conditions were less than three points (=baseline) in both the acceptability and cuteness judgement tasks, and no difference was noted in acceptability and cuteness between the two scores. Therefore, both the acceptability and cuteness order are *hime* > *pime* = *bime*. The order of acceptability and cuteness discussed here is summarised in Table 5, where 'A > B' means that A sounds more acceptable/cuter than B, and 'A = B' means that A sounds as acceptable/cute as B. Whether each order of acceptability and cuteness can be predicted based on the H-score of each candidate is examined in Section 5.5.

	cuteness-sensitive speakers	cuteness-insensitive speakers
acceptability	*hime* > *pime* > *bime*	*hime* > *pime* = *bime*
cuteness	*pime* > *hime* > *bime*	*hime* > *pime* = *bime*

Table 5

The order of acceptability and cuteness for cuteness-sensitive and cuteness-insensitive speakers

5. Modelling the *pime-yobi* nicknaming pattern using Maxent HG

5.1 A brief explanation for Maxent HG

Section 5 presents a Maxent HG analysis based on the results of the current experiments. As already mentioned in Section 1, few studies to date have analysed sound-symbolic effects using formal phonological theory. Recently, however, a number of studies have shown that sound-symbolic effects can be modelled using phonological theory, such as Maxent HG (Kawahara *et al*. 2019, Jang 2020, Kawahara 2020a, 2020b, 2021, Shih 2020). Along this trend, the current study models the *pime-yobi* nicknaming pattern using Maxent HG.

Maxent HG (Goldwater & Johnson 2003, Jäger 2007, Hayes & Wilson 2008) is a probabilistic model based on HG (Legendre *et al*. 1990, 2006, Pater 2009, 2016, Potts *et al*. 2010). In standard HG, the harmonic score (H-score) is calculated for each candidate based on the sum of $C_i * w_i$, where the candidate's violation of each constraint (C_i) is multiplied by the constraint's weight (w_i). The candidate with an H-score that is nearest to zero is selected as the winner. In addition to this basic assumption, Maxent HG uses each H-score to calculate predicted probabilities for all output forms, including harmonically bounded candidates (Jäger & Rosenbach 2006). The procedure is as follows. First, each candidate's eHarmony is calculated in terms of $e^{-(\text{H-score})}$, where e is the base of natural logarithms. Second, Z is calculated by summing eHarmony for all candidates. Finally, the predicted probability of each candidate is eHarmony divided by Z.

The Maxent calculation is illustrated in (8), where two candidates are posited for an input form and relevant constraints: $w_{\text{CONS 1}} = 1$, $w_{\text{CONS 2}} = 2$, and $w_{\text{CONS 3}} = 3$. Candidate 1 incurs two violations of CONS 1 and one violation of CONS 2, and Candidate 2 incurs one violation of CONS 3. In this case, the H-score of Candidate 1 is 4 (= $w_{\text{CONS 1}}*2 + w_{\text{CONS 2}}*1$) and that of Candidate 2 is 3 (= $w_{\text{CONS 3}}*1$), and each eHarmony is 0.0183 (= e^{-4}) and 0.0498 (= e^{-3}), respectively. Z is the sum of each eHarmony (i.e. 0.0183 + 0.0498 = 0.0681). Consequently, for each predicted probability, Candidate 1 is 0.2689 (= 0.0183/0.0681) and Candidate 2 is 0.7311 (= 0.0498/0.0681).

(8) Illustration of Maxent calculation

/input/	Cons 1	Cons 2	Cons 3	H-score	eHarmony	Z	Predicted probabilities
w	1	2	3				
candidate 1	2	1		4	0.0183 (e^{-4})	0.0681	0.2689
candidate 2			1	3	0.0498 (e^{-3})	0.0681	0.7311

The current Maxent HG analysis is based on the results of Experiments 1 and 2. Experiment 1 showed that Japanese speakers found names with two [p]s to be cuter than those with one [p], thereby suggesting that the constraint that requires [p] exhibits counting cumulativity in an HG analysis (Jäger & Rosenbach 2006). Experiment 2 showed that acceptability and cuteness judgments of the variants in *pime-yobi* nicknaming are gradient across different speakers, and that the variant [bime], harmonically bounded by another variant [pime], is selected by some speakers, which is suitable for using the stochastic version of HG (i.e. Maxent HG).

5.2 Constraints

This section explains the four constraints needed for the current analysis. The definition of each constraint is provided in (9).

(9) a. The Express[p] constraint (=Exp[p])
Assign a violation mark to candidates that contain only one singleton [p]. Assign two violation marks to candidates that do not contain any singleton [p]s.

b. Realise Morpheme (=RealMorph)
Assign a violation mark for every morpheme in the input that is not present as a phonological exponent in the output.

c. Ident[F] (=Ident)
Assign a violation mark for every pair of corresponding segments that do not agree in their value of feature [F]. (Here, [F] is considered a [voice] feature.)

d. OCP(Labial) (=OCP(Lab))
Assign a violation mark for a pair of labial consonants within a particular morpheme.

The current analysis posits that the Express[p] constraint in (9a) can count up to two [p]s, based on the Experiment 1 results. For example, the output form [pime] contains only one singleton [p], thereby incurring one violation mark by this constraint; the output forms [hime] and [bime] contain no singleton [p], thereby incurring two violation marks.

The Realise Morpheme (RealMorph) (Kurisu 2001) and Ident[F] (McCarthy & Prince 1995, 1999: 226) constraints in (9b, 9c) are used in the rendaku analysis of Itô & Mester (2003)[3]. Itô &

[3] The definition of RealMorph here is different from the original proposal of Kurisu (2001), in

Mester (2003) posited a featural linking morpheme ℜ specified with [+voiced] and that, for rendaku application, REALMORPH is enforced if the linking morpheme in the input makes a voicing feature realised in the output (e.g. *hako* 'box' + ℜ + *hune* 'ship' → *hako-**b**une* 'ark'). Based on the OT analysis of Itô & Mester (2003), the REALMORPH constraint takes precedence over the IDENT constraint (i.e. $w_{\text{RealMorph}} > w_{\text{Ident}}$). However, the current study deals with not only the *rendaku* form with [h]→[b] alternation (i.e. [hime]→[bime]) but also with the nickname with [h]→[p] alternation (i.e. [hime]→[pime]), and assumes here that [p] and [b] are viewed as phonological exponents—namely, a marker for compoundhood. Thus, not only nicknames attached to [bime] (*rendaku* form), but also those attached to [pime] (*pime-yobi* form) avoid violating REALMORPH.[4]

One might suspect that EXP[P] and REALMORPH functionally overlap with each other, as both induce the [h]→[p] alternation in the *pime-yobi* nicknaming. However, the two constraints are distinguished from each other, for the following reasons. First, a constraint that favours [p] in the output (i.e. EXP[P]) should exhibit cumulativity, as evidenced in Experiment 1, while a constraint that requires a marker for compoundhood (i.e. REALMORPH) does not exhibit cumulativity. Second, there should be a [p]-favouring constraint (i.e. EXP[P]) that is differentiated from a constraint that is satisfied with both output forms, [pime] or [bime], realised as a phonological exponent (i.e. REALMORPH). This is because, as already mentioned in Section 2.3, we observe [h]→[p] alternation as in *pime* but never [h]→[b] alternation as in *bime* in the ambient language data.

The current analysis also posits the OCP(LAB) constraint in (9d), confirmed in a nonce word experiment (Kumagai 2017, 2019). There are monomorphemic native words with two labial consonants in Japanese, such as *mame* 'bean', *mimi* 'ear', and *momo* 'peach'. Thus, the IDENT constraint is highly weighted above the OCP(LAB) constraint (i.e. $w_{\text{Ident}} > w_{\text{OCP(Lab)}}$).

Based on the above explanation, the order of the constraint weight is $w_{\text{RealMorph}} > w_{\text{Ident}} > w_{\text{OCP(Lab)}}$. As seen in Section 2.3, *hime* 'princess' does not undergo rendaku to become **bime* (e.g. *mai-hime* 'dancing girl'; **mai-bime*), and Experiment 2 confirmed that *hime* is more acceptable than *bime* (see Table 5). The word *hime* is chosen as a winner, even though it violates the higher-weighted constraint, REALMORPH. This is caused by ganging-up cumulativity: violations of two (or more) lower-weighted constraints overcome a higher-weighted constraint (Jäger & Rosenbach 2006). In the *hime*→**bime* case, the lower-weighted constraints, IDENT and OCP(LAB), group together to overcome the higher-weighted constraint, REALMORPH, as illustrated in (10).

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which the REALMORPH he proposes is satisfied not only with affixation but also with deletion or metathesis, because he argues that it is satisfied if a derived form can be distinguished from its base form. However, to make the current discussion simple here, the definition in (9b) is used.

[4] This assumption can be motivated by the orthography-based perspective that rendaku is a process adding 'dakuten' (Vance 2007, 2015, 2016, Kawahara 2015, 2018). In the Japanese hiragana/katakana orthographic system, voiced obstruents need a diacritic called *dakuten* (``), and a singleton [p] needs a diacritic called *han-dakuten* (°) (e.g. 'ば'=[ba]; 'ぱ'=[pa]), whereas voiceless obstruents do not require this (e.g. 'は'=[ha]). Thus, the REALMORPH constraint can be defined as a constraint that requires an initial consonant in the second member of the compound to have a [+diacritic] feature.

(10) Rendaku blocking: *hime* → **bime*

			REAL MORPH	IDENT	OCP (LAB)
	input	output			
→	hime	hime	1		
		bime		1	1

Experiment 2 showed that *pime* was judged as a cuter name than *hime* by cuteness-sensitive speakers (see Table 5). This effect is due to the EXPRESS[P] constraint; as shown in (11), *hime* (without [p]) incurs more violation marks by the EXPRESS[P] constraint than *pime*, thereby making the H-score of *hime* further from zero.

(11) *Pime-yobi* nicknaming: *hime* → *pime*

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)
	input	output				
	hime	hime	2	1		
→		pime	1		1	1

5.3 Cuteness-expressive phonology

The current HG analysis captures the gradient acceptability of the *pime-yobi* variants by building on the concept of co-phonology, namely, multiple strata or subgrammars within a language (Itô & Mester 1995, Orgun 1996, Inkelas 1998, Itô & Mester 1999, Anttila 2002; etc.). Two types of co-phonology in Japanese speakers are assumed here: non-expressive phonology, defined as the grammar used for acceptability judgement, and I-expressive phonology, defined as the grammar used for judgement of an image *I*. The current study assumes that the cuteness-expressive phonology used for cuteness judgement is an I-expressive phonology.[5]

5.4 Input data

The current analysis calculates constraint weights using the Maxent Grammar Tool software (Hayes *et al.* 2009) (The input data files are available at https://osf.io/pj5qz/). This calculation requires input data for learning. Data presented in (12) and (13) are the input values for the calculation. Data (12a, 12b) correspond to Conditions 1 and 2 of Experiment 2, respectively. The input-output pair in (12a) assumes two output forms [hime] and [pime] for the input form [hime], and the input-output pair in (12b) assumes two output forms [hime] and [bime] for the same input form. The dotted line indicates the constraint violation profile for each candidate. The four columns

[5] The cuteness-expressive phonology is distinguished from a baby-talk register or children-directed speech, wherein an adult speaker talks as if they were a baby or child (Ferguson 1977, Bombar & Littig 1996). One of the reasons for this is that, although the sound-symbolic [h]→[p] alternation expresses cuteness, it is never observed in Japanese baby-talk words.

in (A, B, C, D) are the frequencies (Table 4 presented in Section 4.5), which were used for constraint weight calculation for each co-phonology: (A) non-expressive phonology in cuteness-sensitive speakers; (B) expressive phonology in cuteness-sensitive speakers; (C) non-expressive phonology in cuteness-insensitive speakers; and (D) expressive phonology in cuteness-insensitive speakers. In terms of the constraint violation profile, candidate [bime] is harmonically bounded by candidate [pime] (i.e. [bime] never overcomes [pime]), but Maxent HG allows us to obtain the probability of all candidates, including the harmonically bounded candidate (Jäger & Rosenbach 2006).

(12) Input data based on Conditions 1 and 2 of Experiment 2

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)	(A)	(B)	(C)	(D)
	input	output					freq.	freq.	freq.	freq.
a.	hime	hime	2	1			99	19	245	282
		pime	1		1	1	89	176	38	13
b.	hime	hime	2	1			119	99	254	266
		bime	2		1	1	67	80	33	31

Data (13) were used as input values to ensure that $w_{\text{RealMorph}} > w_{\text{Ident}} > w_{\text{OCP(Lab)}}$ in Japanese phonology. In (13a), candidate [mame] 'bean' is faithfully selected as a winner, even though it violates the OCP(LABIAL) constraint. In (13b), rendaku application produces [hune]→[bune] 'ship', since the REALMORPH constraint is highly weighted above the IDENT constraint. For the frequency of candidates for each pair, [mame] vs. [name] was assumed to be 1 vs. 0, and [bune] vs. [hune] was assumed to be 1 vs. 0.

(13) Input data to ensure the weight ordering: $w_{\text{RealMorph}} > w_{\text{Ident}} > w_{\text{OCP(Labial)}}$

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)	
	input	output					freq.
a.	mame	mame				1	1
		name			1		0
b.	hune	hune		1			0
		bune			1		1

5.5 Results

The calculation results for cuteness-sensitive speakers' co-phonology are presented here. The non-expressive phonology is presented in (14a) and the cuteness-expressive phonology in (14b). The results showed that the weight of the EXPRESS[P] constraint was higher in cuteness-expressive phonology (14b) than in non-expressive phonology (14a), whereas the weights of the other three constraints remained almost the same in both types of co-phonology. In other words, the EXPRESS[P] constraint plays a crucial role in cuteness judgement. Moreover, the expected probabilities (EP) of each candidate were confirmed to be consistent with the observed probabilities (OP) obtained in Experiment 2 (see Table 4 in Section 4.5).

(14) HG Tableau in cuteness-sensitive speakers

a. Non-expressive phonology

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)	H-score	EP	OP
input	output	*w*	0.4672	33.582	22.775	11.382			
hime	hime		2	1			34.524	0.527	0.527
	pime		1		1	1	34.632	0.473	0.473
hime	hime		2	1			34.524	0.64	0.64
	bime		2		1	1	35.1	0.36	0.36

b. Cuteness-expressive phonology

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)	H-score	EP	OP
input	output	*w*	2.4392	33.258	22.438	11.033			
hime	hime		2	1			38.136	0.0974	0.0974
	pime		1		1	1	35.91	0.9026	0.9026
hime	hime		2	1			38.136	0.553	0.553
	bime		2		1	1	38.349	0.447	0.447

In turn, non-expressive phonology for cuteness-insensitive speakers is presented in (15a) and cuteness-expressive phonology in (15b). The results show that the weight of the EXPRESS[P] constraint was approximately zero for both types of co-phonology (15a, 15b). In other words, the EXPRESS[P] constraint is almost inert for cuteness-insensitive speakers. Hence, for these speakers, the cumulative effect of the EXPRESS[P] constraint is almost irrelevant in determining the optimal candidate. In addition, the EP and OP of each candidate is identical or similar.

(15) HG Tableau in cuteness-insensitive speakers

a. Non-expressive phonology

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)	H-score	EP	OP
input	output	*w*	0.1745	34.91	24.15	12.8			
hime	hime		2	1			35.259	0.866	0.866
	pime		1		1	1	37.125	0.134	0.134
hime	hime		2	1			35.259	0.885	0.885
	bime		2		1	1	37.299	0.115	0.115

b. Cuteness-expressive phonology

			EXP[P]	REAL MORPH	IDENT	OCP (LAB)	H-score	EP	OP
input	output	*w*	0	35.334	24.596	13.265			
hime	hime		2	1			35.334	0.956	0.926
	pime		1		1	1	37.861	0.044	0.074
hime	hime		2	1			35.334	0.896	0.926
	bime		2		1	1	37.861	0.104	0.074

There is an approach to acceptability judgement that a candidate with an H-score closer to zero is more harmonic (e.g. grammatical/acceptable) compared to a candidate with an H-score further from zero (Keller 2000, 2006). This comparison is possible when we compare H-scores across candidate sets (i.e. [hime], [pime], and [bime]) for a particular input ([hime]) (but see Coetzee & Pater 2008 for a problem with this approach). If we take this approach, the order of acceptability and cuteness discussed in Section 4.6 can be predicted by each H-score of the three variants: the close-to-zero order of each H-score is *hime* (34.524) > *pime* (34.632) > *bime* (35.1) in (14a); *pime* (35.91) > *hime* (38.136) > *bime* (38.349) in (14b); and *hime* (35.334) > *pime* (37.861) = *bime* (37.861) in (15b). However, in (15a), the H-score for *pime* (37.125) is not equal to that of *bime* (37.299); thus, the order of acceptability (*hime* > *pime* = *bime*) is not completely predictable. A reason for this unsuccessful result is that the weight of the EXPRESS[P] constraint is not zero, thereby leading to a difference in the H-score between *pime* and *bime*. One solution for this problem is to assume that the weight of the EXPRESS[P] constraint in (15a) is infinitesimally small (i.e., $w_{\text{Exp[p]}} \approx 0$), which would then minimise the difference in the H-score between *pime* and *bime*.

6. Concluding Remarks

6.1 Summary

The current study is briefly summarised in this section. *Pime-yobi* is a new Japanese nicknaming pattern that shows an [h]→[p] alternation to express cuteness. The current study proposes that nicknaming is induced by the EXPRESS[P] constraint, which requires output forms to contain a singleton [p]. The two experiments conducted have shown that the sound-symbolic effect of [p] associated with the image of cuteness is cumulative, and the degrees of acceptability and cuteness for the variants of the *pime-yobi* nicknaming are different across speakers. Based on the experiment results, the current study modelled *pime-yobi* nicknaming patterns using Maxent HG, in which we saw that a [p]-favouring constraint (i.e. EXPRESS[P]) exhibits counting cumulativity, its sound-symbolic effect is gradient across different speakers (i.e. cuteness-sensitive vs. cuteness-insensitive) and within two types of co-phonology (i.e. non-expressive vs. cuteness-expressive), and a variant [bime], harmonically bounded by another variant [pime], is assigned probability.

6.2 Questions for future research

This section discusses whether the EXPRESS[P] constraint is active in languages other than Japanese. The current study has noted in Section 1.2 that the nature of the EXPRESS[P] constraint is rooted in cross-linguistic patterns in phonological development and the frequency code hypothesis, namely, labiality and high frequency. Therefore, the sound-symbolic effect in question should be found in other languages that have [p] or a sound that satisfies the relevant phonetic/phonological features. Recent experimental studies have shown that labial consonants (including [p]) are more likely to be associated with an image of cuteness than non-bilabial consonants across several languages (Kumagai 2020, Kawahara *et al*. 2021, Kumagai & Moon 2021). Further research is needed to examine whether the sound-symbolic effect of labial consonants (including [p]) with respect to cuteness, or a more generalised constraint, EXPRESS[LABIAL], is ubiquitous from a cross-linguistic perspective.

As noted by Alderete & Kochetov (2017) cited in Section 1.1, sound-symbolic effects are yet to be actively discussed in the literature on theoretical phonology. However, recent studies have shown that sound-symbolic phenomena can be modelled using phonological theory, such as Maxent HG (Kawahara *et al*. 2019, Jang 2020, Kawahara 2020a, 2020b, 2021, Shih 2020). The current study contributes to this discussion by proposing a sound-symbolic EXPRESS constraint and modelling a Japanese nicknaming pattern, *pime-yobi*, using Maxent HG.

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Appendix 1: Links to blogs (written in Japanese) (last accessed 2 August, 2022)
To the best of my knowledge, some of these were written as early as 2010.

1. Ayu-pime, yuka-pime: https://www.dclog.jp/en/1008438/527022319
2. Kana-pime: https://profile.ameba.jp/ameba/k7k7pmm
3. Manami-pime: https://www.jalan.net/yad316105/kuchikomi/archive/detail_04107547/
4. Nana-pime: https://withonline.jp/authors/FCvv7
5. Sakura-pime: https://www.ehonnavi.net/ehon00_opinion_single.asp?no=111&rno=167185
6. Yuri-pime: https://www.dclog.jp/yuripime8/9/

Appendix 2: By age and gender analysis
A growing body of sociolinguistic studies shows that factors such as age and gender can lead to different speech styles. There are several studies focusing on speakers' sensitivity to cuteness. Jang (2021) explored how Korean speakers perceive Korean *Aegyo* variants in terms of cuteness, experimentally showing that female and older speakers rated cuteness with higher scores, compared with male and younger speakers. In other words, older female speakers were most sensitive to cuteness in Korean *Aegyo*. In addition, the older female speakers showed the largest difference between high and low scores among the Korean *Aegyo* variants. Beyond linguistics, a psychological study by Nittono (2016, 2019) investigated Japanese speakers' attitudes toward *kawaii* 'cuteness', thereby revealing that Japanese women showed a more positive response to *kawaii* than males, whereas age-related differences were relatively low. He also showed that older female speakers were less sensitive to *kawaii* than younger female speakers. Below, we examine whether the two factors, age and gender, play a role in detecting cuteness-sensitivity speakers. The data files for analysis are available at https://osf.io/pj5qz/.

Table 6 presents the average scores for acceptability and cuteness by gender (43 male speakers vs. 57 female speakers). With regard to cuteness in the [p] condition, no significant difference was found between male (2.74) and female speakers (2.74) (β = 0; *SE* = 0.2204; *df* = 100; *t* = -0.001; *n.s.*). For the results of cuteness in the [b] condition, the male speakers' average score (2.47) was higher than that of female speakers (2.19), although no significant difference was found between the two values (β = 0.2797; *SE* = 0.2174; *df* = 99.997; *t* = 1.286; *n.s.*). These results show that gender does not affect cuteness judgement for *pime-yobi* variants.

	n	acceptability [p]	acceptability [b]	cuteness [p]	cuteness [b]
Males	43	2.48	2.36	2.74	2.47
Females	57	2.42	2.30	2.74	2.19

Table 6
Average scores for acceptability and cuteness (by gender)

Table 7 shows the average scores for acceptability and cuteness by age; the current analysis categorised 47 speakers whose ages were between 18 and 29 years old as 'younger' speakers, and 53 speakers whose age was 30 years old and more as 'older' speakers. The results showed no significant difference between younger and older speakers in the [p] condition (2.89 vs. 2.61; β =

-0.2825; *SE* = 0.2168; *df* = 100.017; *t* = -1.303; *n.s.*), nor in the [b] condition (2.39 vs. 2.23; *β* = -0.1573, *SE* = 0.2169, *df* = 99.997, *t* = -0.725, *n.s.*). These results show that age had little effect on cuteness judgement for the *pime-yobi* variants.

	n	acceptability [p]	acceptability [b]	cuteness [p]	cuteness [b]
younger (<29)	47	2.6	2.47	2.89	2.39
older (>=30)	53	2.31	2.2	2.61	2.23

Table 7

Average scores for acceptability and cuteness (by age)

A further analysis divided all speakers by age and gender into four groups: 30 younger female (YF) speakers, 27 older female (OF) speakers, 17 younger male (YM) speakers, and 26 older male (OM) speakers. The results are presented in Table 8.

	n	acceptability [p]	acceptability [b]	cuteness [p]	cuteness [b]
younger female (YF) speakers	30	2.72	2.56	2.95	2.49
older female (OF) speakers	27	2.09	1.99	2.51	1.85
younger male (YM) speakers	17	2.39	2.29	2.78	2.21
older male (OM) speakers	26	2.53	2.4	2.71	2.63

Table 8

Average scores for acceptability and cuteness (by age and gender)

One noticeable result is that the YF speakers showed the highest score for cuteness in both the [p] and [b] conditions ([p]=2.95; [b]=2.49), whereas the OF speakers showed the lowest score ([p]=2.51; [b]=1.85). Thus, Japanese YF speakers were the most sensitive to cuteness and OF speakers were the least sensitive. These results align with that of Nittono (2016, 2019); female speakers were more sensitive to cuteness than male speakers and female speakers were less sensitive as they grew older.

Another noticeable result is that the OM speakers showed the smallest difference between the [p] and [b] conditions ([p]=2.71; [b]=2.63), whereas they showed the highest score for cuteness in the [b] condition among the other groups. This result suggests that the OM speakers found the *bime* form to be as cute as the *pime* form.

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