Articulatory features of phonemes pattern to iconic meanings: Evidence from cross-linguistic ideophones

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Abstract

Iconic words are supposed to exhibit imitative relationships between their linguistic forms and their referents. Many studies have worked to pinpoint sound-to-meaning correspondences for ideophones from different languages. The correspondence patterns show similarities across languages, but what makes such language-specific correspondences universal, as iconicity claims to be, remains unclear. This could be due to a lack of consensus on how to describe and test the perceptuo-motor affordances that make an iconic word feel imitative to speakers. We created and analysed a database of 1,860 ideophones across 13 languages, and found that 7 articulatory features, physiologically accessible to all spoken language users, pattern according to semantic features of ideophones. Our findings pave the way for future research to utilize articulatory properties as a means to test and explain how iconicity is encoded in spoken language. The perspective taken here fits in with ongoing research of embodiment, motivation, and iconicity research, three major strands of research within Cognitive Linguistics. The results support that there is a degree of unity between the concepts of imitative communication and the spoken forms of through cross-domain mappings, which involve physical articulatory movement.

Keywords: iconicity, ideophones, articulation, phonology, phonosemantics

Declaration of interest: none.

1 Introduction

Iconicity in spoken language is an imitative mapping or relationship between a linguistic form to its meaning (Hinton et al. 1994; Emmorey 2014). One fundamental example of iconicity in spoken language is onomatopoeia, as in the English *woof woof* for the sound of a dog bark or *vroom vroom* for the sound of revving a car engine. An implicit assumption behind iconicity in spoken language is that phonemes are associated to specific units of meaning, acting as imitative scaffolding that comes together to form a meaningful structure (see Figure 1 for Japanese). For example, the /ŋ/ in English /diŋ.doŋ/ seems characteristic of the reverberating echo of a bell tolling, while the alternating /i/ and /o/ seems characteristic of a

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perceived movement or perceived fluctuation in pitch as the bell tolls. While various studies have worked to list phonemic sound-to-meaning correspondences for a given language (McCune 1983; Maduka 1988; Oswalt 1994; Hamano 1998; 2019; Ofori 2009; Assaneo et al. 2011; Akita et al. 2013; Ayalew 2013; Kwon and Round 2015; Blasi et al. 2016; De Carolis et al. 2017; Strickland et al. 2017; Aryani 2018; Kawahara et al. 2018), it is unclear why or how such correspondences exist in the first place.

To understand why these sound-meaning correspondences exist, we need to ask: what properties make speech sounds imitative? Answering this question would allow linguistics and cognitive scientists to move toward a more unified understanding of what in the spoken modality should be classified as "iconic" and why. Speech sounds consist of both aural (acoustic) and kinetic (articulatory) properties. Without wanting to discount the importance of acoustics, this paper opts to examine articulatory, and therefore gestural or movement-based, properties of ideophones—words known to be imitative or depictive (Dingemanse 2012; 2019; Akita and Dingemanse 2019).

Ideophones are marked words which depict sensory imagery (Dingemanse 2012) and belong to an open lexical class because speakers are known to improvise them on the spot (Dingemanse 2019). Ideophones include onomatopoeia but further span a range of imitative meanings beyond just that of SOUND (Dingemanse 2012: 663), e.g., MOTION in *kamúkamú* 'countermovement of buttocks while walking' of Pichi (Yakpo 2019), COGNITIVE STATES *ŋẽʔŋẽʔ* 'manner of being baffled or dazed' of Chaoyang (Zhang 2016), or OTHER SENSORY PERCEPTIONS and *chun* 'complete absence of sound' of Pastaza Quichua (Nuckolls and Swanson 2019). Recent studies have likened ideophones to gestures made with the mouth, given their synchrony with iconic hand gestures in natural speech (Nuckolls 2000; Dingemanse 2013; 2015; Mihas 2013; Hatton 2016). In her fieldwork, Hatton (2016: 47) noted that speakers consistently executed gestures depicting something and simultaneously said ideophones which depictively corresponding to those gestures. Ideophones as "oral gestures" is a notion that highlights the importance of articulatory movement in our pursuit of understanding just how ideophones mean what they mean. Ideophones have been shown to be easily learnable by speakers from different language backgrounds, which may speak to their gesturally imitative nature—where meaning is encoded and perceivable despite obvious differences between languages, such as phonotactics, phonological inventory, or lexical associations (Iwasaki 2007a; 2007b; Dingemanse et al. 2016; Lockwood et al. 2016;). If we understand how movement or gesture is meaningful in the context of ideophones then we should be able to know (1) why sound-meaning correspondences exist, and (2) what properties make speech sound imitative. Ideophones are an ideal testing ground for how articulatory properties, i.e., mouth movements, pattern to meaning.

Vocal imitations and onomatopoeia created spontaneously by participants in experimental settings (Assaneo et al. 2011; Perlman et al. 2015; Lemaitre et al. 2016; Perlman and Lupyan 2018; Taitz et al. 2018), although improvised and therefore not lexical, have been shown to exhibit consistent sound-meaning correspondences. These correspondences can also be attributed to patterns in articulation (Assaneo et al. 2011; Taitz et al. 2018), reinforcing our investigative focus on the articulatory properties of phonemes in ideophones because contrasts among them are realized with varying articulatory parameters (see Section 3.3).

In a methodological vein similar to Blasi et al. (2016), our study looks at whether articulatory features of consonants (e.g., occlusion of airflow, sibilant airflow, nasality) and vowels (e.g., high and back tongue positions, rounding of the lips) are more or less attested in certain semantic domains of ideophones (e.g., telic events, human vocal sounds, motion, appearance).[4] If an articulatory gesture is more attested in one semantic domain of ideophones than another, this could explain why some sound-meaning correspondences might be perceived as imitative and therefore iconic of a given percept. Such correspondences would therefore be explainable as perceptuo-motor affordances grounded in gestural means, e.g., the total closure of plosive articulation, affords the semantic category of telic events and their percept "coming to an abrupt stop." We created a database of ideophones from 13 languages (in total, 1860 ideophones) to carry out our investigation on how articulatory properties of phonemes pattern with ideophone meaning.

2 Background

2.1 Phonosemantics: the study of sound-meaning correspondences

The subfield of phonosemantics subscribes to a broad hypothesis that "every phoneme is meaning-bearing," in a word and that that meaning "is rooted in its articulation" (Diffloth 1972, 1979; Hamano 1998; see Dingemanse 2018 for review). Phonemic sound-meaning correspondences, henceforth phonosemantic mappings, have been proposed for a number of languages (Maduka 1988; Waugh 1994; Hamano 1998; Oswalt 1994; Assaneo et al. 2011; Akita et al. 2013; Ayalew 2013; Kwon and Round 2015; Blasi et al. 2016). For example, the appearance of /p, b/ in ideophones to do with explosions, expectoration, or releases of pressure is explained through the articulatory properties of /p, b/ themselves (a blockage of airflow then followed by a release) which gesturally resemble those meanings. In the present study, even though we do not assume that absolutely all phonemes are necessarily meaning -bearing in all contexts, we do subscribe to the notion that the phonosemantic mappings of ideophones should be "rooted in its articulation," following previous studies (Diffloth 1994; Oda 2000; Strickland et al. 2017; Taitz et al. 2018).

Figure 1 illustrates how Hamano (1998: 40) assigned phonosemantic mappings to the CVCV root structure of Japanese ideophones. The tier structure (upper box of Figure 1) illustrates the broader categories of meaning in the CVCV context, i.e., if a phoneme is in X

[4] Unlike Blasi et al. (2016), we do not base our analysis on a cross-linguistic set of words resembling a Swadesh list but, instead, focus on ideophones, i.e., words which are perceived as imitative in nature. The semantic domains in our study follow descriptive and theoretical work on ideophone meaning (Diffloth 1972; 1979; Dingemanse 2012; Hamano 1998; Van Hoey 2018; Nuckolls et al. 2017).

position it depicts a Y kind of percept (Talmy 2000). The lower box of Figure 1 shows what each phoneme specifically means in the Japanese ideophone *poka-poka* 'a dull, hollow sound.'

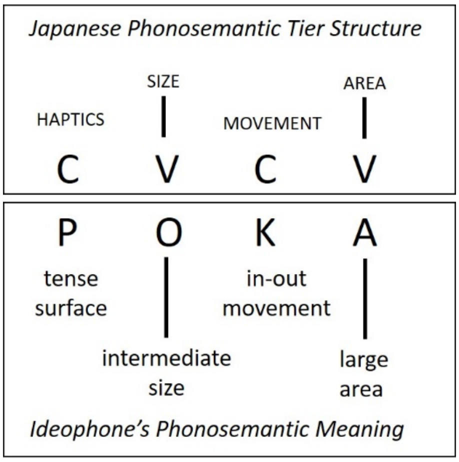


Figure 1: Hamano's (1998:40) phonosemantic analysis of Japanese ideophones exemplified by *pokapoka* 'a dull, hollow sound'.

Although Hamano's (1998) analysis of Japanese ideophones draws conclusions which have since been disputed by some (Haiman 2018: 121-122) and revised by others (Akita et al. 2013; Nasu 2015), the basic principle remains the same for phonosemantic analyses from other languages: each phoneme depicts an iconic percept. Hamano's (1998) tier-based analysis, though exemplary, is designed with the strict CV phonotactics of Japanese in mind and is not applicable to other languages.[5] While intuitive yet cursory phonosemantic analyses are found throughout the language-specific chapters of *Sound Symbolism* (Hinton et al. 1994) and *Ideophones* (Voeltz and Kilian-Hatz 2001), these often verge on impressionistic and suffer from a lack of cross-linguistic comparison. This issue can be mitigated by investigating cross-linguistic ideophone systems for their mappings between phonology and semantics. This is the route we intend to take in this study.

3 Cross-linguistic ideophone database

3.1 Database

Though language-particular databases for ideophones are becoming more widespread, e.g., the Chinese Ideophone Database (Van Hoey and Thompson 2020), the Quechua Real Words project (Nuckolls et al. 2017) or the Multimedia Encyclopedia of Japanese Mimetics (Akita 2016), there is currently no cross-linguistic database dedicated solely to ideophone inventories. We created a database of 13 languages which were selected with the aim of being as

[5] The specific criticism of Hamano's analysis being that she did not use enough minimal pairs to support the analysis illustrated in Figure 1 (Haiman 2018:121-122).

typologically diverse as possible (see Figure 1) despite the limited number of linguistic descriptions for ideophone inventories in the world. Our major criterion for selecting languages is that 40 or more ideophones were reported per source. Number of ideophones per language and language family are reported in Table 1. Due to their depictive nature, and the various methods of collection (fieldwork elicitation, dictionaries), the ideophone inventory numbers reported in Table 1 are not absolute, but instead reflect a general picture about the semantic "visibility" of ideophones per language. This is in line with a claim recently put forth by Dingemanse (2019) that ideophones form an open class, speaking to the creative potential of speakers to coin new ideophones. The languages in our database are as follows: Manyika Shona (Franck 2014), Uyghur (Wang and Tang 2014), Manchu (Xiao 2015), Chaoyang Southern Min (Zhang 2016), Ma'ai Zhuang (in prep),[6] Kam Dong (Gerner 2005), Akan (Ofori 2009), Kisi (Childs 1988), Kuhane (Mathangwane and Ndana 2014), Pastaza Quichua (Nuckolls et al. 2017), Upper Necaxa Totonac (Beck 2008), Temne (Kanu 2008), and Yakkha (Schakow 2016). They are alternatively presented in Figure 2 according to geographic distribution.

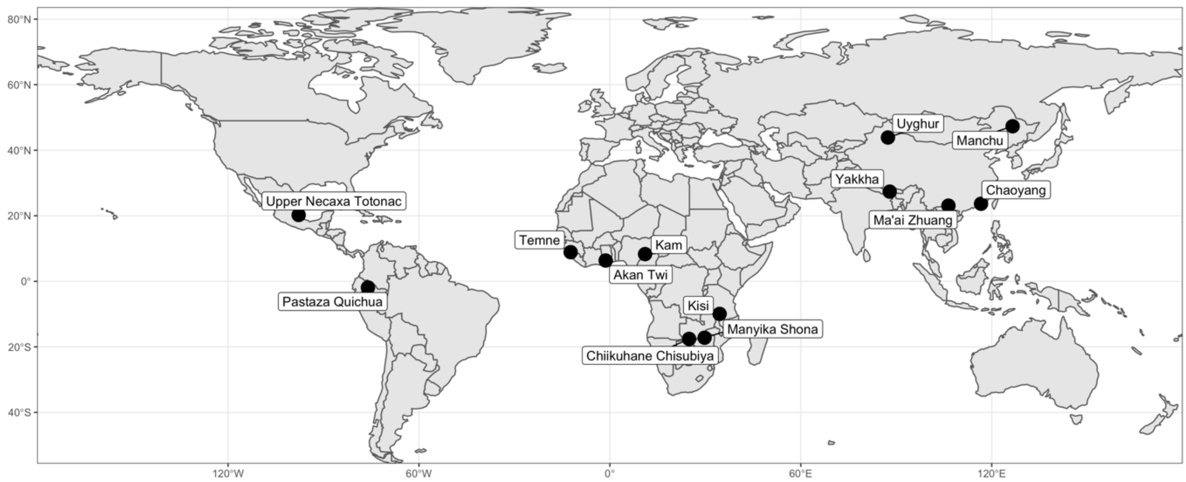


Figure 2: Geographic representation of the languages in the database

Table 1: Languages, number of ideophones, and language families in the database

Language name [glottocode]	Language family	Ideophone types
Akan Twi [akan1250]	Niger-Congo	188
Kisi [kisi1243]		96
Kuhane / Mbalangwe [subi1246]		65
Manyika Shona [shon1251]		111
Temne / Themne [timn1235]		76
Chaoyang Southern Min [chao1238]	Sino-Tibetan	246

[6] Ma'ai Zhuang ideophones have been collected during ongoing fieldwork. A full list is available in OSF repository, which holds the supplementary materials (https://osf.io/6bhz8/)

Yakkha [yakk1236]		64
Ma'ai Zhuang / Langjia Buyang [yang1286]	Kra-Dai	231
Kam / Southern Dong [kamm1249]		216
Manchu [manc1252]	Tungusic	91
Uyghur [uigh1240]	Turki	49
Pastaza Quichua [nort2973]	Quechuan	281
Upper Necaxa Totonac [uppe1275]	Totozoquean	146
Total: 13	**8**	**1,860**

3.2 Semantic features

Definitions per ideophone were entered into the database according to how they were described in the source documentation. Minor stylistic changes in the wording of some definitions were made to synthesize them across languages, e.g., "sound of a dog's bark" and "sound of barking dog" were entered as "sound of barking dog" for consistency. These subtle differences in the word choice of the source documentation were interpreted as a product of English syntax rather than of ideophone meaning itself. If an ideophone was reported with multiple definitions, e.g., "sound of flowing water; peeing", each was entered separately into the database, i.e., once for "sound of flowing water", and once for "peeing", in line with strategies set forth in the Cross-Linguistic Data Format paradigm (Forkel et al. 2018).

Definitions for reduplicated forms were entered into the database only if they were described differently from non-reduplicated equivalents. Each definition was coded with semantic features created in correspondence with Dingemanse's (2012: 663) implicational hierarchy of ideophones (see Akita 2009; McLean 2020; Van Hoey *in print* for alternative approaches). Dingemanse's (2012) hierarchy begins with monomodal depiction of sound as its most fundamental category and goes on to include four other cross-modal semantic categories: SOUND < MOVEMENT < VISUAL PATTERNS < OTHER SENSORY PERCEPTIONS < COGNITIVE STATES. For each of these categories, 9 binary semantic features (Table 2) were created based on cross-linguistic ideophone research on the observations of what ideophones depict across languages (Hamano 1998; Hinton et al. 1994; Nuckolls et al. 2016; Van Hoey 2018). It is important to note that these semantic features are not mutually exclusive. An ideophone may be coded for multiple, seeing as most ideophones are multisensory (Nuckolls 2019; McLean 2020). For example, the Chaoyang /hu.hu/ 'wind blowing' was coded with [+sound] (because this ideophone depicts an auditory percept), [-telic] (because this ideophone does not involve a perceived endpoint of an event), [+wind] (because this ideophone involves a percept created by the movement of air), and [-motion] (because this ideophone is not depictive of a motion plus a resulting state or manner).

Table 2: Semantic features used to code ideophones

Semantic category	Semantic feature	Description of positive value [+]
sound	[+/- sound]	depicts auditory information ("the sound of X")
	[+/- loud]	auditory information of inherently high amplitude, i.e., explosion, screaming, shattering
	[+/- human]	vocalization made by people, i.e., laughter, crying, talking
	[+/- animal]	vocalization made by animals
movement	[+/- motion]	depicts active ("the act of X") movement, i.e., walking, chopping, splashing, sneaking, flapping, water boiling, bumping, spitting, firecrackers exploding
	[+/- wind]	depicts movement of air, bodily or otherwise, i.e., blowing, coughing, gales
visual patterns	[+/- appearance]	depicts visual information, i.e., how something looks or degrees of visibility
other sensory perceptions	[+/- friction]	depicts rubbing together or rough contact of surfaces (not necessarily active movement), i.e., grinding, rustling, sharpening, hacking up phlegm, tearing cloth
cognitive states	[+/- telic]	depicts an event which reaches completion

While the assignment of semantic features based solely on textual documentation is a far from perfect methodology when it comes to capturing the subtle nuances, multisensory percepts, and contextual meaning variations of ideophones, it is not yet clear what sort of methodology, and what extent of native speaker input, would even render such a goal possible. Hand gestures have been shown to be an insightful tool when it comes to eliciting semantic percepts of ideophones which native speakers may find too subtle to verbalize (Dingemanse 2015). There also are at least three ideophone dictionaries which make use of visual information to explain the meanings of ideophones (Akita 2016; Gomi 1989; Nuckolls et al. 2017). However, since this calibre of detailed documentation is only available for two languages so far, we are forced to contend with textual definitions for (1) determining semantic features, and (2) sentence examples (if provided) for any basis of contextual meaning variation. Therefore, our assignment of semantic features is based on inference of semantic properties which are inherent to or implied by the definitions provided in their documentation. Examples from Kuhane are given in Table 3.

Crucially, if a percept was not explicitly stated then it was not reflected in our assignment of semantic features. For example, one could imagine that the Kuhane ideophone /gwa/ 'sound of entering abruptly' depicts a kind of visual information, rendering it [+appearance]. However, because Mathangwane and Ndana (2014) did not specify anything in their definition of /gwa/ about visual information, our semantic coding was thus 'sound' = [+sound], 'of entering' [+motion], and 'abruptly' [+telic]. Likewise, /tʃevutʃevu/ 'looking around continuously' was coded as 'looking' [+appearance], 'looking around' [+motion], and 'continuously' [-telic]. A more challenging example is /tʃootʃoo/ 'whispering,' this was coded as [+human] since it is an action done by humans, [+sound] because it is an auditory percept, and [+wind] because it involves a depiction of (sibilant) air movement. However, it was not obvious whether to code ‘whispering’ as [+motion] or [-motion]. Is ‘whispering’ an active and discriminable form of movement, comparable to that of ‘chopping’ or ‘splashing’ or is ‘whispering’ simply an auditory percept? If a semantic feature was called into question, we chose to err on the side of caution and thus refrained from coding that feature, i.e., the feature value assigned was negative by default.

A native English speaker coded the entire database and two other native English speakers who did not know the purpose of the study, checked whether they (a) fully agree, (b) maybe agree, or (c) disagree with the coding. The agreement rate between the three raters (the first author and the two independent raters) was 0.73, and Gwet’s AC1 was 0.80, which indicates quite high reliability.[7] We filtered out 14 items out of 1,874 ideophones**,** where both raters disagreed with the assigned features. We would like to restate that the purpose of this study is not to provide a detailed semantic analysis of the remaining 1,860 ideophones. Rather, what we strive for is to determine whether general properties of ideophone meanings pattern according to articulatory properties of phonemes.

Table 3: Examples of Kuhane ideophones coded with semantic features

Kuhane item	**Meaning**	**Semantic features**								
		sound	loud	human	animal	motion	wind	appearance	friction	telic
gwa	‘sound of entering abruptly’	+	-	-	-	+	-	-	-	+
zwi	‘fullness’	-	-	-	-	-	-	+	-	-
fi.si.fi.si	‘simmering of a pot’	+	-	-	-	+	-	-	-	-
hwe.hwe	‘talkative’	+	-	+	-	-	-	-	-	-
tʃa.pa.tʃa.pa	‘sound of splashing’	+	-	-	-	+	-	-	+	+
si.ku	‘sound of a hiccough’	+	-	+	-	+	+	-	-	+
ku.lje	‘sound of a bird’	+	-	-	+	-	-	-	-	-
bu.ku	‘totally red’	-	-	-	-	-	-	+	-	-
tʃe.vu.tʃe.vu	‘looking around continuously’	-	-	-	-	+	-	+	-	-
pwa.tʃa.pwa.tʃa	‘treading on rotten melons’	+	-	-	-	+	-	-	+	+
gu	‘sound of thunder’	+	+	-	-	-	-	-	-	-
tʃoo.tʃoo	‘whispering’	+	-	+	-	-	+	-	-	-

[7] Fleiss’s κ was -0.00632, which is quite low. This is presumably due to the complex nature of the rating task, i.e., judging the multisensoriality of a large number of definitional paraphrases. As argued by Hoek and Scholman (2017), Gwet’s AC1 (2002) might be a better measure for interrater agreement in linguistics.

3.3 Articulatory features

All consonants were coded using 7 binary features, listed in Table 4, according to how lips, tongue, and airflow, are involved in their articulation. Our coding follows a linear order of phonemes. Just as the semantic features are based on cross-linguistic observations of ideophones, our articulatory features are also empirically driven by previous ideophone research in that they have been shown to create lexically contrastive meanings for ideophone inventories across different languages (Diffloth 1972; 1979; Hamano 1998; 2019; Oswalt 1994; Strickland et al. 2017; Li 2007; Thompson and Do 2019). It is important to note the articulatory features here are different from traditional phonological features, like those of Chomsky and Halle's *SPE* (1968) or Clements' feature geometry (1985). Our features illustrate *contrastive movements* required for a phoneme to be realized but not for a phoneme to be differentiated from *other phonemes* per se. For this reason, phonemes like /d/ and /l/ may be assigned an identical set of feature values. Our features referring to oral contact, tongue resting, and tongue root were designed to account for manner without reference to place of articulation. The reason for having [+/- tongue resting] as a feature, as opposed to [+/- tongue movement], was to acknowledge that tongue body and tongue tip movement may occur in some articulations but not as an active or direct result of articulation. In these cases, the tongue assumes an inactive position which may vary slightly according to the sound being made (Gick et al. 2004). See the accompanying OSF repository for a full list of phonemes coded with their articulatory features.[8]

Table 4: Articulatory features used to code the consonants of ideophones

Articulatory feature	**Description of positive value [+]**	**Example phonemes**
[+/- labial]	active movement of the lips	/p, b, …/
[+/- tongue resting]	tongue body and tongue tip are not actively involved in articulation	/p, b, h, ʔ, …/
[+/- tongue root]	usage of back of tongue (dorsum), as with velars	/j, k, g, ŋ …/
[+/- airflow]	air is forced out through a narrow channel in the mouth, as with fricatives	/f, v, s, z, …/
[+/- velum] (nasal)	velum is lowered and air escapes through the nasal passage, as with nasals	/m, n, …/
[+/- oral contact]	active contact made either by tongue or lips	/p, b, t, d, …/
[+/- vocal folds]	movement of the vocal folds, as with modal voicing	/b, d, n, r, …/

The binary nature of our 7 features means 14 possible feature values overall. If properties of iconicity are truly universal, then we predict that the universally accessible properties captured by our articulatory features should bear the explanatory power for what perceptuo-motor affordances underpin iconicity and its notions of (analogical) depiction. While some feature values can subsume others, i.e., [+/- oral contact] subsumes [+/- labial], the decision to

[8] The OSF repository can be found here: https://osf.io/6bhz8/

test the subsumable [+/- labial] is again to do with lexical contrasts observed. For example, in Chaoyang we have [+labial] [+oral contact] /pu.pu/ meaning 'rapid movement' and [-labial] [+oral contact] /tsu.tsu/ 'whispering.' Likewise, in Pastaza Quichua we have [+labial] [+oral contact] /pɑw/ 'manner of being turned downward' and [-labial] [+oral contact] /kɑw/ 'sound of stepping on dry leaves.' We also include the subsumable feature [+tongue root], again, given its ability to create lexical contrasts. For example, in Akan Twi we have [+tongue root] [+oral contact] /kuu/ 'call of a large bird' and [-tongue root] [+oral contact] /tuu/ 'manner of hitting with the fist.' The reason we created these subsuming features was so that the general manner of the consonant is accounted for regardless of its place of articulation in the oral tract.

The vowels attested in ideophones were coded using 5 binary features, listed in Table 5, according to the position of the tongue relative to the extremities of the oral cavity and whether lip rounding is involved in articulation.

Table 5: Articulatory features used to code the vowels of ideophones

Articulatory feature	Description of positive value [+]	Example phonemes
[+/- high]	tongue positioned higher in the oral cavity; jaw more closed	/I, y, ɪ, ʏ…/
[+/- low]	tongue positioned lower in the oral cavity; jaw more open	/a, ɶ, ɑ, ɒ…/
[+/- front]	tongue positioned toward the front of the oral cavity	/ e, ø, ɛ, œ…/
[+/- back]	tongue positioned toward the back of the oral cavity	/ɯ, u, ɤ, o…/
[+/- round]	lips are rounded	/ y, ʏ, ø, œ…/

4 Predictions

We have 4 specific predictions about the articulatory-semantic feature relations of consonants based on observations from the phonosemantic literature. These observations are grounded in perceptuo-motor analogy but have yet to be tested for ideophone inventories across languages. (1) Fricatives, i.e., [+airflow], have been associated to wind or friction between two objects (Oswalt 1994; Ofori 2009; Taitz et al. 2018). Improvised vocal imitations have suggested that (2) consonants involving lip movement, i.e., [+labial], are associated with the sounds resulting from motion, i.e., [+motion], (3) while dorsal consonants, i.e., [+tongue root], are associated with movement itself (Taitz et al. 2018) i.e., [+motion] in our feature set. (4) Stop consonants, characterized by total occlusion of airflow, i.e., [-airflow], have been observed for ideophones indicating complete, i.e., [+telic], events or events with abrupt endings (Alpher 1994; Strickland et al. 2017; Taitz et al. 2018). The analysis below aims to inspect these predictions but also go beyond them.

The four predictions:

(1) a. [+airflow] is associated with [+wind]

b. [+airflow] is associated with [+friction]

(2) [+labial] is associated with [+motion]

(3) [+tongue root] is associated with [+motion]

(4) [-airflow] is associated with [+telic]

Although we have included vowels in our analysis, this was done out of phonological completeness rather than any predictions regarding phonosemantic mappings. But given the gestural properties of vowels, there are two predictions to be made following what is posited for consonants above. We predicted that fricatives, i.e., [+airflow] consonants, will correspond to the positive semantic features [+wind] and/or [+friction]. High vowels, like fricatives, are also characterized by a narrowed opening in the oral cavity. Therefore, we predict that [+high] vowels are also associated with [+wind] and/or [+friction]. Likewise, since lip rounding involves lip movement, we predict that [+round] vowels are associated with [+motion], as we have predicted for [+labial] consonants above. Finally, we predict that [+low] vowels are associated with [+loud] because, according to the Sonority Hierarchy (Clements 1990), low vowels are theoretically loudest of all vowels. That being said, we caveat these predictions with the observation that for some minimal pairs the difference of vowels does little to contrast the ideophone meaning, e.g., English /bæm/ [-front] vs. /bum/ [+front] where both ideophones are arguably interchangeable in that both depict the slamming (of doors) or bursting/explosion. Additionally, vowel alternation in reduplicated ideophones, e.g., English /splɪʃ.splæʃ/ 'splashing,' is understood as characteristic of a fluctuation or rhythmic movement in the event being depicted (see Hinton et al. 1994; Voeltz and Kilian-Hatz 2001). It would seem then that consonants (/spl_ʃ/) provide a depictive frame for the event in question, while vowels add a kind of auxiliary information such as pitch or intensity, e.g., /splɪʃ/ 'small impact on and into liquid,' /splæʃ/ 'impact on and into liquid,'/spluʃ/ 'large impact on and into liquid.' With such caveats in mind, we cannot be sure whether our aforementioned predictions regarding vowels will be empirically supported.

5 Analysis

5.1 Collostructional methodology

As outlined above, the goal of this study is to check if meaningful relations, such as the four predictions made above, exist between articulatory and semantic features, and why this is so. We operationalize this by using the collostructional framework (Stefanowitsch and Gries 2003; Gries 2019), in order to investigate the correlations between form (articulatory features) and meaning (semantic features). The fundamental idea of collostructional approaches consists of tallying co-occurrences of features to be investigated and placing them in a contingency table. Let us first illustrate this framework with an application from construction grammar.

Suppose we wanted to know which noun is most likely to occur in the English construction [N *waiting to happen*] (Stefanowitsch and Gries 2003). One could start by collecting corpus data to gather all token frequencies of nouns in this position, which would provide some measure of insight into the usage. However, it is more informative to find out that there is some degree of special attraction between the N and the constructional slot in [N *waiting to happen*]. This requires a method to inspect the relative strength between N and the constructional slot. One then can proceed to make contingency tables for all nouns that are identified in that construction.

The nouns found for this construction by Stefanowitsch and Gries (2003), together with their token frequency in brackets are: *accident* (14), *disaster* (12), *welcome* (1), *earthquake* (1), *invasion* (1), *recovery* (1), *revolution* (1), *crisis* (1), *dream* (1), *it (sex)* (1), and *event* (1). As shown in Table 6, this means that *accident* occurs 14 times in this construction (cell a), while 21 times there is another word that occurs in it (cell b). The token *accident* occurs 8,606 times in other constructions (cell c), while logically there are 10,197,659 constructional contexts that do not feature *accident* (cell d).

Table 6: Crosstabulation of accident and the [N waiting to happen] construction (Stefanowitsch and Gries 2003:219)

	accident	**- accident**	**Row totals**
[N waiting to happen]	(a) 14	(b) 21	35
- [N waiting to happen]	(c) 8,606	(d) 10,197,659	10,206,265
column totals	8,620	10,197,680	10,206,300

The next step in the collostructional approach is to use an association measure to calculate the relative strength between the Ns and the construction. While Gries and Stefanowitsch initially adopted the Fischer-Yates Exact test (Stefanowitsch and Gries 2003; Gries and Stefanowitsch 2004a; Gries and Stefanowitsch 2004b), which calculates the mutual strength between N and the constructional slot, there has been a shift towards directional association measures in more recent work (see Gries 2019). For example, "according" in *according to* attracts "to" more than that "to" attracts "according", since *to* is a simple preposition. Or the other way around, "instance" attracts "for" more in *for instance* than "for" attracts "instance". Of course, (near) perfect attraction can exist with unique combinations, such as *bona fide* (Gries 2019:393). A well-established unidirectional association measures that takes contingency into account (Ellis and Ferreira-Junior 2009; Levshina 2015) is ΔP, which comes in two variants: $\Delta P_{noun \rightarrow construction}$ and $\Delta P_{construction \rightarrow noun}$, the details for calculation will be given below (see 5-6 below). This way it becomes possible to see how much a construction attracts a given N to its slot, but also conversely how much a given N attracts (or repels) that construction.

Gries (2019) suggests that what then remains is the discussion of the results after bringing together a number of indicators, such as showing both ΔPs, token frequency size, dispersion etc. In our application of this method, we are dealing with type frequencies of ideophone inventories. Consequently, we will not go as far, but will provide an extra step of linear regression on which to base our discussion with regards to the four predictions made above.

5.2 Database analysis: consonants

The application of collostructional methods to ideophone-related studies is not new, see Smith (2015) for a study on phonesthemes in Old Chinese reduplicatives, or Van Hoey (2020) for applications to ideophones as they occur in Mandarin constructions. This study adopts collostructional method for investigating associations between articulatory features and semantic features. As a reminder, the articulatory features (n = 7 x binary distinction = 14) are provided in Table 4, and the semantic features (n = 9 x binary distinction = 18) in Table 3. We counted each logically possible combination of semantic and articulatory features per language, shown for [wind] and [airflow] in Akan Twi in Table 7 as an example. Calculating this combination for other languages, together with their respective ΔP values, results in Table 8. Note that both ΔP values are calculated as follows (5-6). In these formulas, *a*, *b*, *c*, and *d* stand for cells in the contingency table, as shown in Table 7.

Table 7: Crosstabulation of wind and airflow in Akan Twi

Akan Twi	[+wind]	[-wind]	Row totals
[+airflow]	(a) 11	(b) 19	30
[- airflow]	(c) 31	(d) 213	244
column totals	42	232	274

Based on the counts in Table 7, the ΔP of [+wind] to be realized with [+airflow] is, i.e., $\Delta P_{+\,semantic\,\rightarrow\,+articulatory} = \frac{-1}{30} - \frac{31}{244} = 0.24$ and ΔP of [+airflow] to get involved in the meaning of [+wind] is, i.e., $\Delta P_{+articulatory\,\rightarrow\,+semantic} = \frac{-1}{42} - \frac{19}{232} = 0.18$. These numbers indicate that in both directions there is an attraction between the semantic feature of [+wind] and the articulatory feature [+airflow] in Akan Twi, with the semantic → articulatory relation stronger than the opposite. In order to check if there are any associations between an active articulator [+ articulatory feature] and the absence of a semantic feature [- semantic feature], e.g., the pair [+ airflow] and [- wind], we have adapted the formulas for the calculation of the respective ΔP values (7-8). In practice, these values will result in the opposite polarity of the [+articulatory] ~ [+semantic] pairs. In the case of [+airflow] and [-wind], $\Delta P_{-\,semantic\,\rightarrow\,+\,articulatory} = -0.24$ and $\Delta P_{+\,articulatory\,\rightarrow\,-\,semantic} = -0.18$. We analyzed the relation between [+ articulatory] ~ [+/- semantic], excluding the [- articulatory] ~ [+/- semantic] pairs, because a core question here is how *active* articulatory gestures, realized as positive articulatory features, are correlated to semantic features.

(5) $\Delta P_{+semantic\,\rightarrow\,+\,articulatory} = \frac{a}{a-+\,b} - \frac{c}{c\,+\,d}$

(6) $\Delta P_{+\,articulatory\,\rightarrow\,+\,semantic} = \frac{a}{a-+\,c} - \frac{b}{b\,+\,d}$

(7) $\Delta P_{-\,semantic\,\rightarrow\,+\,articulatory} = \frac{b}{a-+\,b} - \frac{d}{c\,+\,d}$

(8) $\Delta P_{+\, articulatory \rightarrow -\, semantic} = \frac{b}{b{-}+d} - \frac{a}{a+c}$

The ΔP values for the combination [+wind] and [+airflow] across languages are provided in Table 8 as an example. It can be seen that different languages display different relational strengths for this semantic-articulatory pair. For this specific relation between [+wind] and [+airflow], $\Delta P_{+semantic \rightarrow +articulatory}$ overall shows higher values than $\Delta P_{+articulatory \rightarrow +semantic}$, suggesting that it is more likely to predict an articulatory feature [+airflow] from a semantic feature [+wind] than vice versa.

Table 8: $\Delta P_{+semantic \rightarrow +articulatory}$ and $\Delta P_{+articulatory \rightarrow +semantic}$ of [+wind] and [+airflow] for all 13 languages

Language	$\boldsymbol{\Delta P_{+semantic \rightarrow +articulatory}}$	$\boldsymbol{\Delta P_{+articulatory \rightarrow +semantic}}$
Yakkha	0.448	0.196
Kisi	0.596	0.193
Akan Twi	0.240	0.180
Manchu	0.267	0.176
Kam	0.315	0.077
Temne	0.693	0.069
Ma'ai Zhuang	0.377	0.058
Chiikuhane Chisubiya	0.548	0.057
Pastaza Quichua	0.487	0.054
Chaoyang	0.230	0.053
Manyika Shona	0.146	0.030
Uyghur	0.042	0.014
Upper Necaxa Totonac	0.041	0.009

It is easiest to first glance at the different combinations of ΔP statistics by visualizing them. The figures for all correlations (see Appendix) show the ΔP correlations with the nine semantic features for each of the seven articulatory features. The data points are the thirteen different languages. Warm colors represent the [+ articulatory] ~ [+ semantic] pairs; cool colors the [+ articulatory] ~ [- semantic] pairs. If a datapoint is situated in the upper right quadrant, it means there is a mutual attraction between semantic and articulatory feature, although not necessarily of the same strength. In the lower left quadrant, it indicates mutual repellence. Even though other relations did not occur in our data, a datapoint in the upper left quadrant would indicate that a semantic feature is more likely to attract an articulatory feature under consideration than vice versa; and a datapoint in the lower right quadrant would show that an articulatory feature attracts a semantic feature but this semantic feature does not rely on this articulatory feature at all. We have also added polygons (brown and turquoise respectively), which display the spread of the different points, as well as a linear regression line (respectively, red and steel blue) for each plot, which will be treated below, as the second type of finding. A relatively widespread polygons indicate that the strengths of the correlations across languages are disperse; a narrowly scoped area, on the other hands, indicates that languages pattern more closely together in terms of the ΔP correlations. Let us illustrate the findings with the pairs involving [+airflow] as an example in Figure 3.

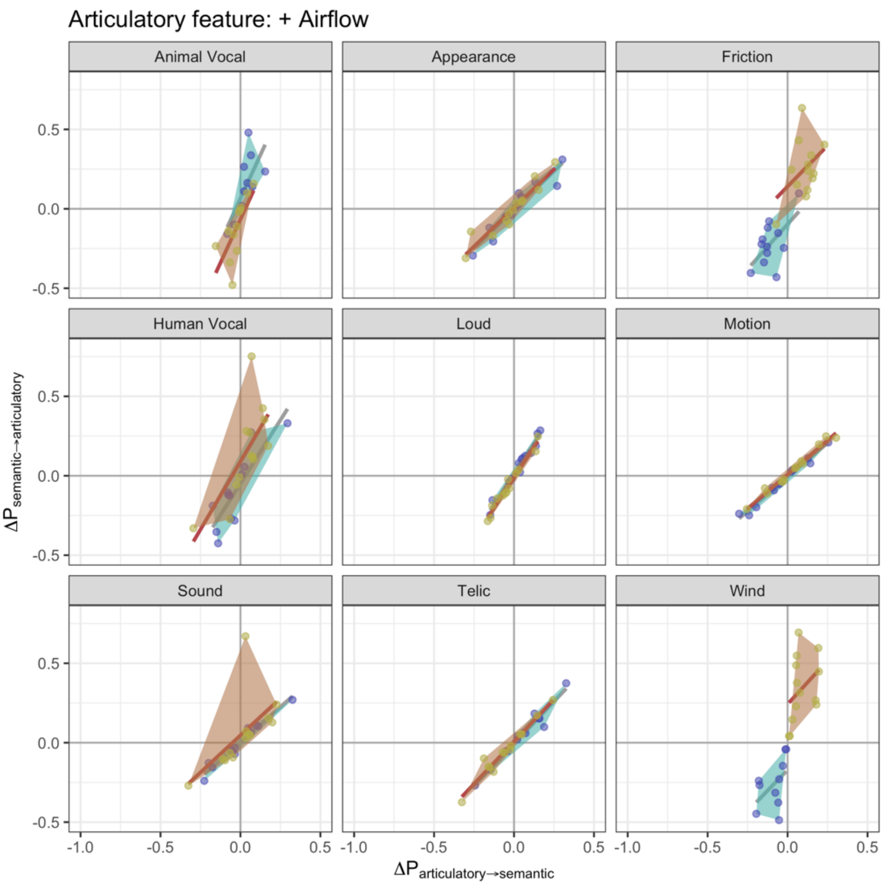


Figure 3: $\Delta P_{semantic \rightarrow articulatory}$ and $\Delta P_{articulatory \rightarrow semantic}$ correlations for the articulatory feature [+airflow] and the nine semantic features. Datapoints in the upper right quadrant for each panel are said to mutually attract each other; in the lower left quadrant they mutually repel each other. The polygons indicate the spread of the datapoints. Linear regression lines have been added as well. Warm colors indicate the values for [+semantic] and [+articulatory] pairs; cool colors for [- semantic] and [+ articulatory] pairs.

Figure 3 shows the correlations the articulatory feature [+airflow] with the nine semantic features under our consideration. Prediction (1a) states that [+ airflow] will be associated with wind or friction. We see that all data points for the pair [+airflow] and [+wind] (Figure 3, lower right panel) are in the upper right quadrant, indicating that there is attraction from articulatory feature to semantic feature (x-axis) and also vice versa from semantic feature to articulatory feature (y-axis). It can thus be said that the prediction is corroborated. For [+ airflow] and [-wind] we find the reverse: the active articulator [+ airflow] is mutually repellent with regards to the absence of [wind]. Turning to the pair [+airflow] and [+friction], prediction (1b), (Figure 3, upper right panel), the story is largely the same: almost all of the language datapoints are situated in the upper right quadrant. As a consequence of these two pairs, when encountering fricatives in an ideophone, there is a reasonable probability that wind or friction is depicted. However, do note that wind and friction rely more on the articulatory features than that these features attract them. In other words, there is mutual attraction, but it is not of the same strength.

In Tables 9-10, we show the semantic-articulatory pairs for which 11 or more of the 13 languages show mutual attraction and mutual repellence. The plausible motivations for these highly correlating pairings will be discussed below.

Table 9: Mutual attraction (upper right quadrant in the plots, see figures in the appendix)

Semantic feature	Articulatory feature	Languages (n)
+wind	+airflow	13
+friction	+airflow	12
+motion	+labial	12
+appearance	+vocal folds	11
+motion	+tongue resting	11
+telic	+tongue root	11
+wind	+tongue resting	11

Table 10: Mutual repellence (lower left quadrant in the plots, see figures in the appendix)

Semantic feature	Articulatory feature	Languages (n)
+friction	+velum	12
+sound	+vocal folds	12
+friction	+vocal folds	11
+human vocal	+vocal folds	11
+wind	+tongue root	11
+wind	+velum	11
+wind	+vocal folds	11

Let us investigate for which pairs the correlations between $\Delta P_{+/-semantic \rightarrow +articulatory}$ and $\Delta P_{+articulatory \rightarrow +/-semantic}$ values are very tight. We do this by calculating linear regression models for all pairs. Because we are interested in the predictive ability of the models rather than the intercept and slope values, we first inspected the F-ratio, omitting ratios smaller than 1. In this step, no models were omitted. Next, we took out the accompanying p-values that were greater than 0.05, leaving 60 pairs. Finally, we inspected the adjusted R^2 for the models. Since we wanted to focus on the tightest fits, we chose an arbitrarily cut-off point of 0.90. This resulted in 11 pairs. Note that this does not mean that other pairs did not have any correlation; rather, the predictive correlation between $\Delta P_{+semantic \rightarrow +articulatory}$ and $\Delta P_{+articulatory \rightarrow +semantic}$ is the strongest for the remaining pairs, which are listed in Table 11. After the consideration of vowels (Section 5.3), the following discussion session (Section 6) will explain implications of significant correlations found from consonants and vowels against our predictions.

Table 11: The remaining 11 pairs which have the tightest linear regression model

Semantic feature	Articulatory feature	***F*-ratio**	***F*-ratio *p*-value**	**Adjusted R^2**
+motion	+vocal folds	622	4.9e-11	0.981
+motion	+airflow	490	1.8e-10	0.976
+motion	+tongue root (dorsal)	487	1.9e-10	0.976
+telic	+labial	416	4.3e-10	0.972
+loud	+airflow	311	2.1e-09	0.963
+telic	+tongue root (dorsal)	285	3.3e-09	0.959
+telic	+airflow	237	8.7e-09	0.952
+loud	+vocal folds	159	7.0e-08	0.929
+loud	+velum (nasal)	120	3.0e-07	0.908
+motion	+labial	118	3.3e-07	0.907
+appearance	+tongue root (dorsal)	111	4.5e-07	0.901

To sum up, both types of findings show that indeed some articulatory properties of consonants pattern to semantic features corresponding to aspects of ideophone meaning. This implies that articulatory schematic properties of phonemes, universally accessible to all speakers, are important in forming the perceptuo-motor analogies that make ideophone meaning iconic.

Below we will discuss what may be the reason why some semantic and articulatory feature pair displays mutual attraction (Table 9), mutual repellence (Table 10) or displays a tight correlation between its ΔP values (Table 11).

5.3 Database analysis: vowels

The vowels were analysed following the same method as for the consonants. We had 3 main features, each with binary distinction, resulting in 6 features: [+ front]/[+ back], [+high]/[+low], [+rounded]/[+unrounded], that were paired with the 9 semantic features. Like with the consonants, we have two types of findings.

As with the consonants, the first analysis concerns the mutual attraction and repellence of vowel features and semantic features. As can be seen from Tables 12-13, there was no pair that occurred for all 13 languages in our sample. To be consistent with the consonant analysis, we set a threshold to 11 languages: if 11 or more languages show the correlation between the two features, we analysed those correlations. Under this set of criteria, we found 3 significant correlations (Table 12). For the pair [+motion] and [+unround], while there was an overall significant correlation between the two, most values are not clustered around the upper right edge or lower left edge (Figure 4, panel 3). This suggest that a general correlation can be found, but it is on the weaker end (the maximum absolute value is ca. |0.2|). The pair [+sound] and [+back] (Figure 4 panel 1) has some datapoints that are more skewed toward an upper right edge, indicating a somewhat stronger correlation between the two, although the range is also much wider. The pair [+wind] and [+low] (Figure 4, panel 2) showed the strongest negative values from among 11 languages. For this correlation one can putatively suggest that the sound of wind typically is perceived as and thus depicted as higher pitched, resulting in an avoidance of low vowels across ideophone systems.

Table 12: Mutual attraction (upper right quadrant)

Semantic feature	Articulatory feature	Languages (n)
motion	unround	11
+sound	+back	11

Table 13: Mutual repellence (lower left quadrant)

Semantic feature	Articulatory feature	Languages (n)
+wind	+low	11

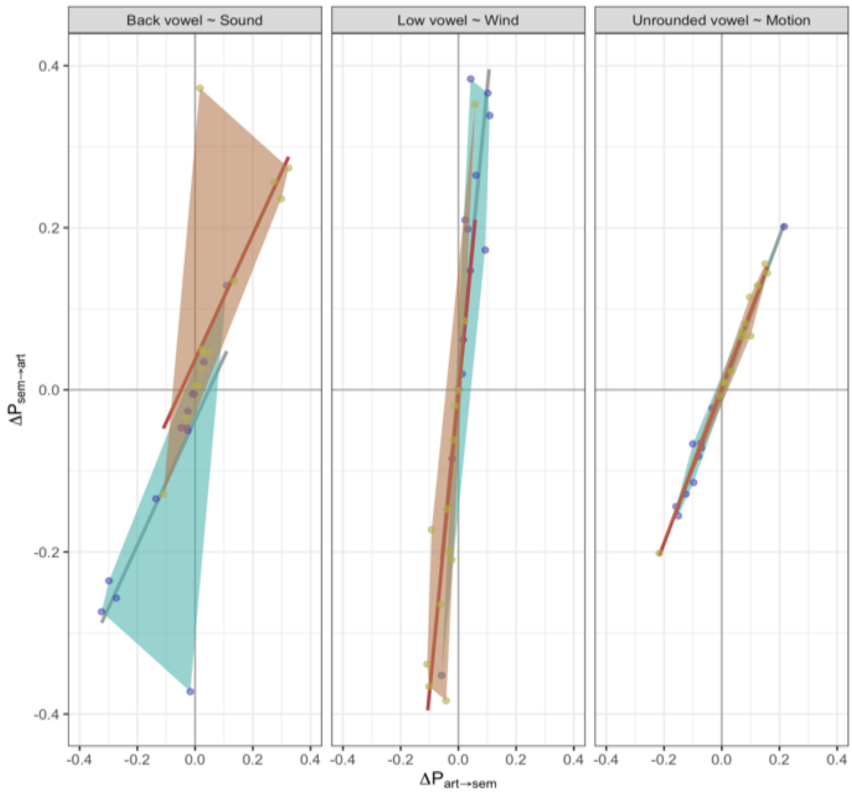


Figure 4: $\Delta P_{+semantic \rightarrow +articulatory}$ and $\Delta P_{+articulatory \rightarrow +semantic}$ correlations for the three vowel features that display mutual repellence and mutual attraction. Note that we have used a different scale to present these three tables than the one used in all other figures.

Like for consonants, the second analysis focuses on the highest *F*-ratios, the concomitant *p*-value (< 0.05) and the adjusted R^2 (> 0.90). As can be seen in Table 14, we find 17 pairs for which the ΔP values are quite similar: if there is a positive attraction from articulatory feature to semantic feature, e.g., [+low] and [+telic], there is also an almost equal positive attraction from semantic feature to articulatory feature. These correlations are meaningful but the distributions of the correlation points from different languages are scattered as well as clustered together, meaning that there is no clear systematic patterns in terms of the directions of the correlations. This distributional tendency is different from the analysis of consonants, where almost all correlations were found from similar clusters, indicating that languages show similar distribution of each correlation.

Table 14: The remaining 17 pairs which have the tightest linear regression model

Semantic feature	Articulatory feature	*F*-ratio	*F*-ratio *p*-value	Adjusted R^2
telic	low vowels	680	3.1e-11	0.983
loud	unrounded vowels	664	3.5e-11	0.982
motion	unrounded vowels	646	4.0e-11	0.982

motion	rounded vowels	566	8.2e-11	0.979
motion	high vowels	475	2.1e-10	0.975
motion	front vowels	419	4.2e-10	0.972
telic	rounded vowels	358	9.6e-10	0.968
loud	front vowels	327	1.6e-09	0.965
telic	unrounded vowels	299	2.5e-09	0.961
motion	low vowels	287	3.1e-09	0.960
loud	back vowels	240	8.0e-09	0.952
loud	low vowels	185	3.2e-08	0.939
loud	rounded vowels	181	3.5e-08	0.938
telic	back vowels	179	3.8e-08	0.937
telic	front vowels	164	6.0e-08	0.931
appearance	low vowels	151	9.2e-08	0.926
telic	high vowels	138	1.4e-07	0.920

6 Discussion

Our analysis shows that certain articulatory properties map to semantic features of ideophones in almost all 13 languages. Broadly speaking, we have shown that articulatory properties of phonemes, physiologically accessible to all spoken language users, are meaningful for ideophones across multiple unrelated languages. This provides empirical support that ideophones serve as units of depictive movement which function much like iconic hand gestures except that ideophones are made with the mouth and not the hands (Nuckolls 2000; Dingemanse 2013; 2015; Mihas 2013; Hatton 2016). Our results show that mouth movement can serve as basis for establishing the depictive nature of ideophones through analogy between linguistic sounds and what is perceived or observed by speakers. While studies have shown that perceptuo-motor analogies are attested in novel words improvised by participants in laboratory settings (Assaneo et al. 2011; Taitz et al. 2018), our study shows that perceptuo-motor analogies exist in real words, consistently, across multiple languages. Perceptuo-motor analogies are termed phonosemantic mappings henceforth.

We tested for mutual attraction and repellence to show which articulatory features have meaningful relations with semantic features and linear correlation for the correlation between those relations. Such analysis was conducted both for consonants and vowels. The phonosemantic mappings exhibited by mutual attraction and linear correlation are largely to do with articulatory properties of consonants, rather than vowels, as predicted. Aside from [+wind], semantic features pertaining to acoustic information, e.g., [+/-loud], [+/-sound], [+/-human vocal], [+/- animal vocal], did not pass our analysis and its threshold of significance in 11 or more languages. Our articulatory features, based on movement, do not capture acoustic depiction very well. This also reflects an already observed disconnect between depictive movement and its relevance to depicting sound. From her fieldwork on Pastaza Quichua ideophones, Hatton (2016) found that onomatopoeia, i.e., ideophones depicting sound, almost never occurred with iconic hand gestures, a stark contrast from the other ideophones she analysed. It seems likely that movement is irrelevant when the depictive aim is only that of sound. In a similar vein, the semantic feature [+/- appearance], relating to the depiction of visual information, did not come through our analysis either. It is not surprising, then, that the semantic features which did make it through our analysis are monomodal: properties of movement (articulation) depict properties of movement (motion-related events). Summarily, movement for movement.

More specifically, our database analysis results show that phonosemantic mappings as proposed in the literature (§4, predictions 1-3) are supported, while [+/-tongue root] was not significant for [+/- motion] as claimed by hypothesis (4) and [-airflow] was not significant for [+telic] in terms of attraction (see Table 11 for linear model). According to our analysis of mutual attraction, four modes of articulation create robust cross-linguistic patterns with regards to imitative meaning: lip movement, tongue in resting position, airflow, and involvement of tongue root. Repellence was shown for the pairs [+velum] and [+friction] as well as [+tongue root] and [+wind], highlighting the inability or, at least, unlikelihood for certain articulatory gestures to scaffold certain semantic features. This suggests that the imitative nature of ideophones is begotten from analogies afforded by such articulatory properties. That is to say, imitative words to some extent derive their depictive meaning through their articulation, implying that articulatory properties of speech are a potential route for explaining how ideophone meanings have been shown to be easily learned and guessed relative to other words (Lockwood et al. 2016; Dingemanse et al. 2016; Iwasaki 2007a; 2007b). By extension, words of contested iconic nature could thus be deemed more or less iconic depending on whether their articulatory properties support such a claim.

Table 15: Predicted phonosemantic mappings and their results

Predicted phonosemantic mapping	Result
[+wind] [+airflow]	see mutual attraction, Table 9
[+friction] [+airflow]	see mutual attraction, Table 9
[+motion] [+labial]	see mutual attraction, Table 9
[+motion] [+tongue root]	only 10 languages showed mutual attraction, but see Table 11 for linear model
[-airflow] [+telic]	no mutual attraction attested, but see Table 11 for linear model

If iconicity is imitative due to relations made between sensory percepts and movements (Dingemanse et al. 2015), then articulatory properties should likewise map to semantic features for reasons grounded in perceptuo-motor analogy. In Table 16, we propose analogical explanations that allow these articulatory properties to pattern with their semantic features and are in turn embedded in ideophones on a sub-phonemic level.

Table 16: Analogical justifications for attraction relations between articulatory and semantic feature pairs across at least 11 of 13 languages

Relation	Semantic	Articulatory	Justification (≈ analogical to)
attraction	[+wind]	[+airflow]	continual airflow ≈ air movement
	[+friction]	[+airflow]	airflow sibilance ≈ sibilance of friction and/or rubbing together of two surfaces
	[+motion]	[+labial]	movement of lips ≈ motion depiction
	[+motion]	[+tongue resting]	see [+motion] above, tongue resting allows for movement of the lips to depict motion
	[+telic]	[+tongue root]	the occlusion of airflow ≈ end of an event
	[+wind]	[+tongue resting]	see [+wind] above, tongue resting allows for airflow to exit the mouth uninhibited

There are few things worth noting regarding the overlap of semantic features. Firstly, the articulatory feature [+airflow] corresponds to semantic features [+friction] and [+wind] but not to motion. This does not imply that [+friction] ideophones are not coded for movement related meaning (as friction must imply some kind of movement). Rather, this implies ideophones which are not necessarily to do with motion,[9] and are thus beyond motion on Dingemanse's (2012) semantic hierarchy for ideophones, involve [+airflow]. With that in mind, the finding that [+labial] corresponds to [+motion] would imply that some (not necessarily complete) occlusion of airflow made by contact with the articulators, is involved in the perceptuo-motor analogy of [+motion]. This is because [+labial] allows for labio- and labiodental fricatives which are consonants coded as [+airflow]. However, here we would argue that it is the movement of the articulators, not the blockage of air, which affords this analogy of movement and, perhaps, the visible movement of lips. The phonosemantic mapping of [+telic] to [+tongue root] seems likewise less straightforward. What about tongue root involvement analogically relates to an event reaching completion? Upon closer inspection, the majority of [+tongue root] consonants in [+telic] ideophones are /k/ and /ŋ/, both of which involve an occlusion of airflow in the mouth.[10] This would make our [+telic] to [+tongue root] phonosemantic mapping equivalent to our predicted [+telic] to [-airflow] phonosemantic mapping (see Section 4). There is a phonotactic explanation for why the nasal /ŋ/ maps to [+telic]. It has been proposed that the coda position of syllables maps to the end of depicted events (see Thompson and Do 2019). However, not all languages allow stops in the coda position of syllables, such as Akan Twi, Manyika Shona, Kisi, or Upper Necaxa Totonac, but these languages do allow nasals like /ŋ/ in coda position, thus permitting the occlusion of airflow which in turn affords the [+telic] mapping. This is the case for Japanese, where only the nasal /n/ is allowed in coda position and

[9] There are very few ideophones in our database which are [+motion] but [-sound]. If ideophones are [+motion] they are almost always [+sound], implying that the sound is resultative of the motion and somehow semantically entails it. For example, an ideophone for 'the sound of footsteps' would be [+sound] and [+motion]. The reverse however is not true. For example, 'the sound of a cow' or 'the sound of wind blowing' is [+sound] but [-motion].

[10] For [+telic] ideophones, the [+tongue root] consonants across all languages: /k/ (138), /ŋ/ (70), /j/ 28/, /x/ (9), /c/ (4), /g/ (4).

ideophones ending in /n/ are considered [+telic] (Akita 2009), e.g., *gachagacha* 'clattering' (of dishes) versus *gachan* 'clank' (of a single dish being set down).

Finally, since ideophones frequently cooccur with iconic hand gestures—timing with the peak of the hand gesture, and since we have shown that some ideophones are depictive through movement, ideophones are perhaps spoken language equivalents of what is known as Echo Phonology (Woll and Sieratzki 1998; Woll 2001; 2009; 2014), a phenomenon observed in sign languages whereby mouth movements are timed to hand movements in iconic signs. As with the articulation of ideophones, mouth movements in the Echo Phonology of sign languages also differ according to the hand movement with which they occur. In the context of evolutionary linguistics, Woll (2014) discusses the importance of Echo Phonology as a contemporary look into how iconic hand gestures can link to or result in speech sounds, and what this link might mean for the historical emergence of spoken (proto-)language. This paper also shows that ideophones provide fertile ground for examining this potential link, especially if future ideophone research involves hand gestures.

7 Conclusion

Our results show that certain articulatory properties pattern with semantic features while others do not. Therefore, some perceptuo-motor analogies could be language-specific. These language-specific results may have come about for a number of reasons. Firstly, phoneme inventories differ across languages so it is inevitable that some languages make use of certain articulatory features less than others, e.g., voicing. Crucially, we did not take predictable phonotactic processes into account when entering the ideophones into our database. Phonotactic processes could result in the addition or deletion of certain segments in order to satisfy language-specific phonological rules and thus potentially obscuring and/or skewing the articulatory features present for imitative purposes only. Another possible reason that some patterns were not borne out could be due to the kind of semantic features used in this study. Additional semantic features may have brought more patterns to light. What we would like to emphasize, however, is that our main goal here was to see if there were any cross-linguistic articulatory-semantic patterns despite the presence of language-specific phonotactic patterns. The significance of six phonosemantic mappings (Table 16) show that this is possible.

Future directions of research could look into how syllable structure affects the patterning of articulatory features with semantic features. Given that we only report correlations between individual articulatory features and individual semantic features, future tests could look at how features cluster together, e.g., [+labial] [-airflow] or [+telic] [+motion]. Experimental research could test the results of our study by seeing whether (1) articulatory feature and semantic feature patterns are easily learnable for novel words or ideophones, (2) speakers refer to these articulatory features – or perhaps exaggerate them – when explaining the meaning of ideophones, as with Dingemanse's (2015) study on folk definitions of Siwu ideophones.

Overall, our results support phonosemantic mappings grounded in articulatory properties of phonemes as well as syllable position. Though we did not consider acoustic properties of phonemes, our findings demonstrate the explanatory power of articulation for imitative structures in spoken language. Movement is meaningful for constructing imitative units in spoken language, just as movement is meaningful for shaping visual forms of communication, such as sign language or hand gestures (Bellugi and Klima 1976; Lieberth and Gamble 1991; Campbell et al. 1992; Brentari 2010; Lai and Yang 2009; Perniss et al. 2010; Emmorey 2014; Ortega 2017; Östling et al. 2018; Perlman et al. 2018).

Within Cognitive Linguistics, our results fit within the ongoing investigation of embodiment (Rohrer 2007; Bergen 2015) and motivation (Radden and Panther 2004). Rather than studying potential iconicity in the prosaic lexicon (Winter 2019), our study has examined truly iconic forms of words, i.e., ideophones. By using unidirectional mappings of attraction and repellence, we have come one step closer to disentangling the cross-linguistic basis of sound symbolism. However, these deserve further experimental testing to do the cognitive commitment justice (Lakoff 1991; Dąbrowska 2016): we need converging evidence from other cognitive sciences beyond linguistics, such as psychology, to further delineate the nature of iconicity. We also recognize that further study of the socio-linguistic contexts (the socio-semiotic commitment, see Geeraerts 2016) in which ideophones are used is necessary to paint an even fuller picture. Finally, we note that the fields of iconicity studies and cognitive linguistics have been colliding to include gesture (Cienki 2016; Occhino et al. 2017), as mentioned above. The cross-domain mappings between spoken and visual forms of communication involve articulatory movement and physical motion, and we have shown a number of ways in which the cross-linguistic support for these mappings may be realized, and investigated in future research.

Appendix

Figure 1: Oral contact

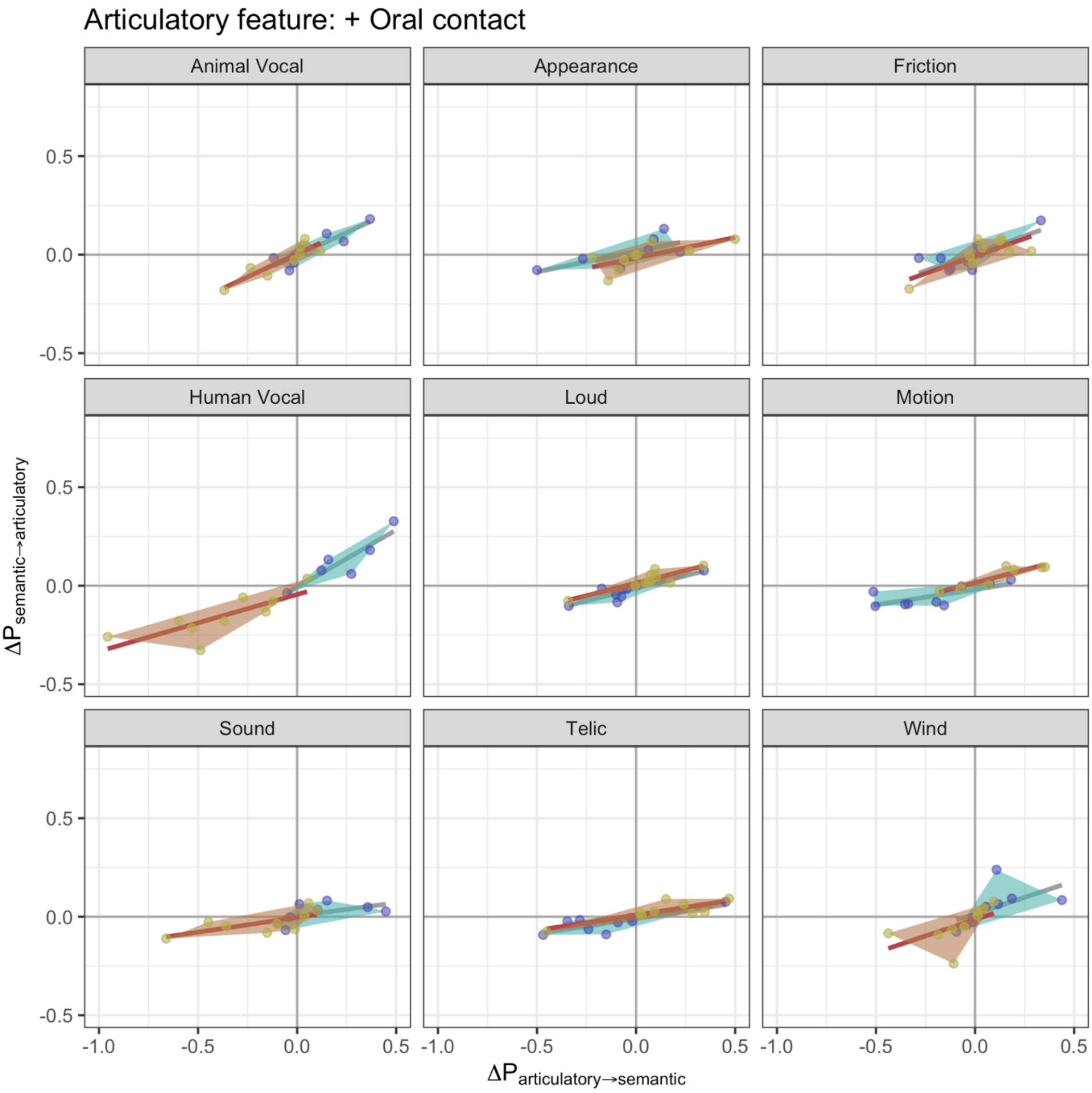


Figure 2: Velum (nasal)

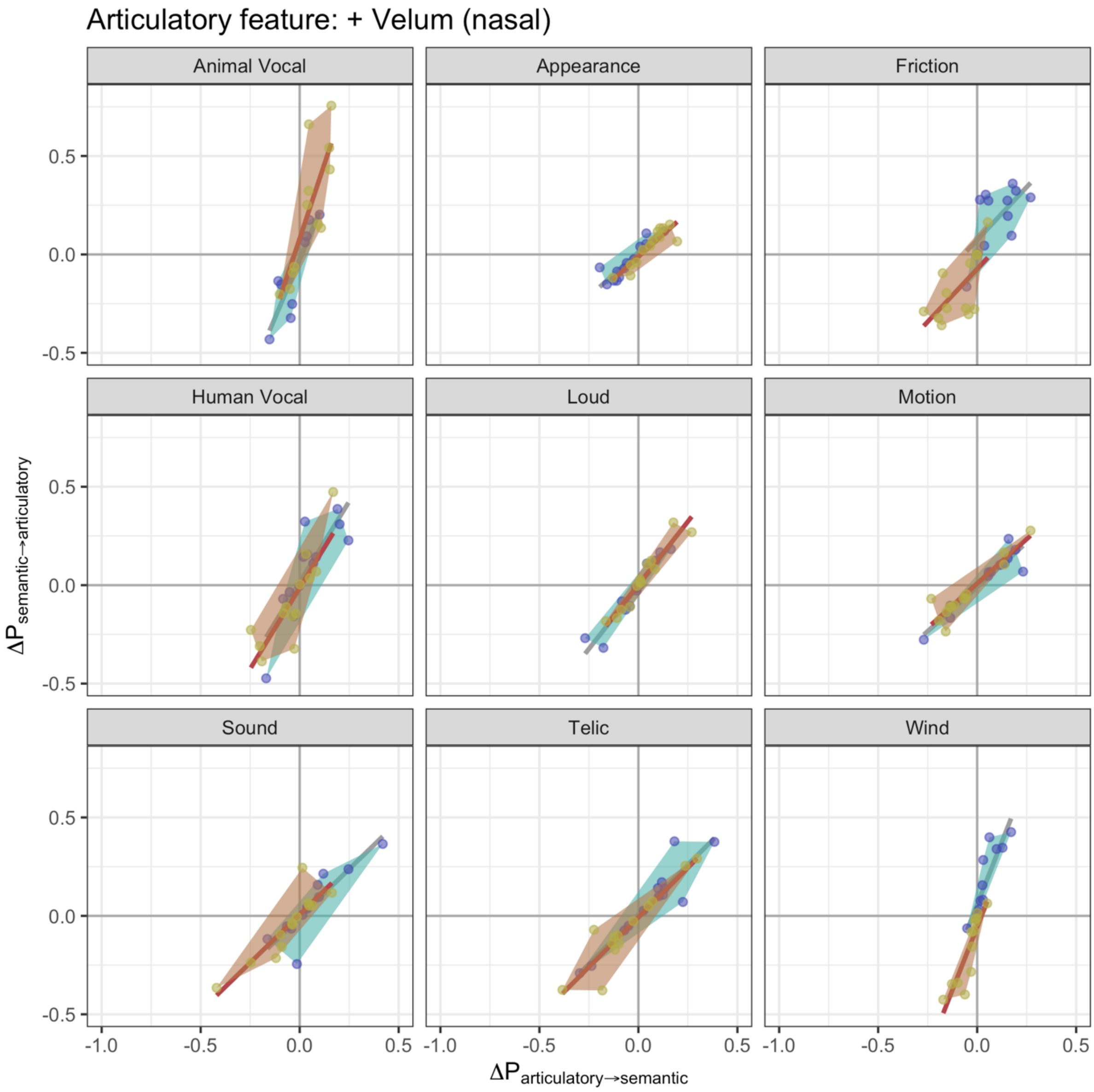


Figure 3: Labial

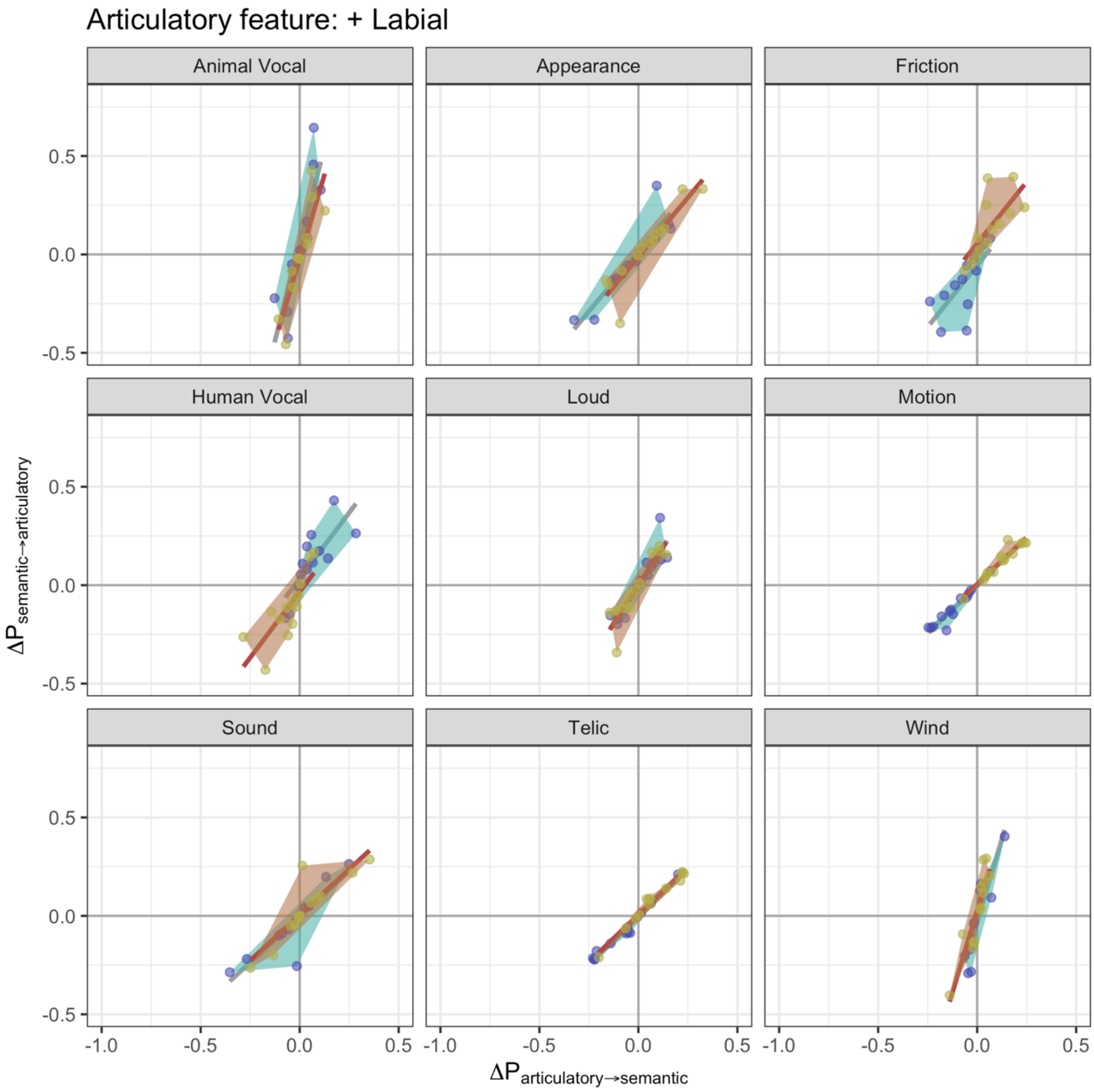


Figure 4: Airflow

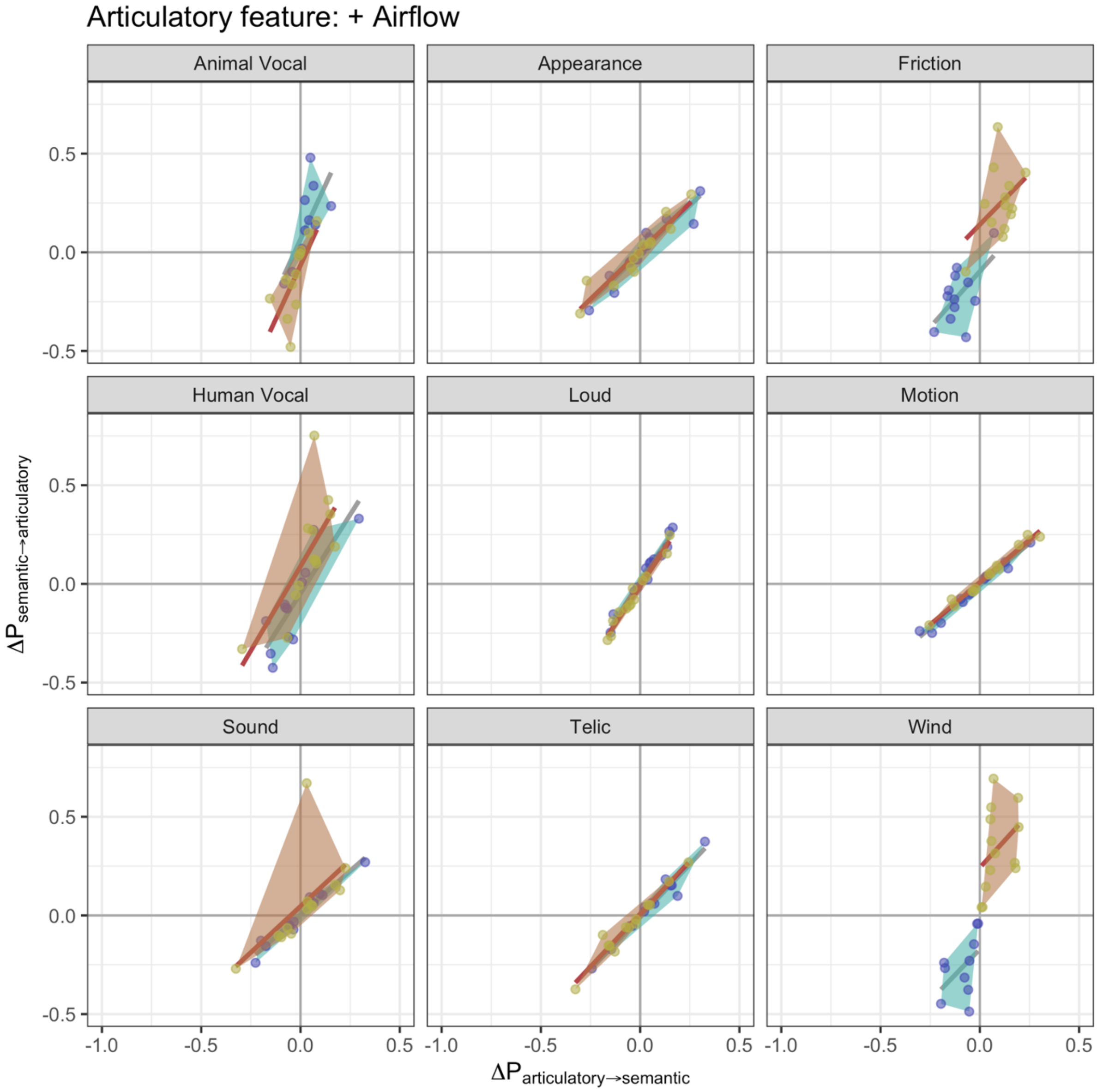


Figure 5: Tongue resting

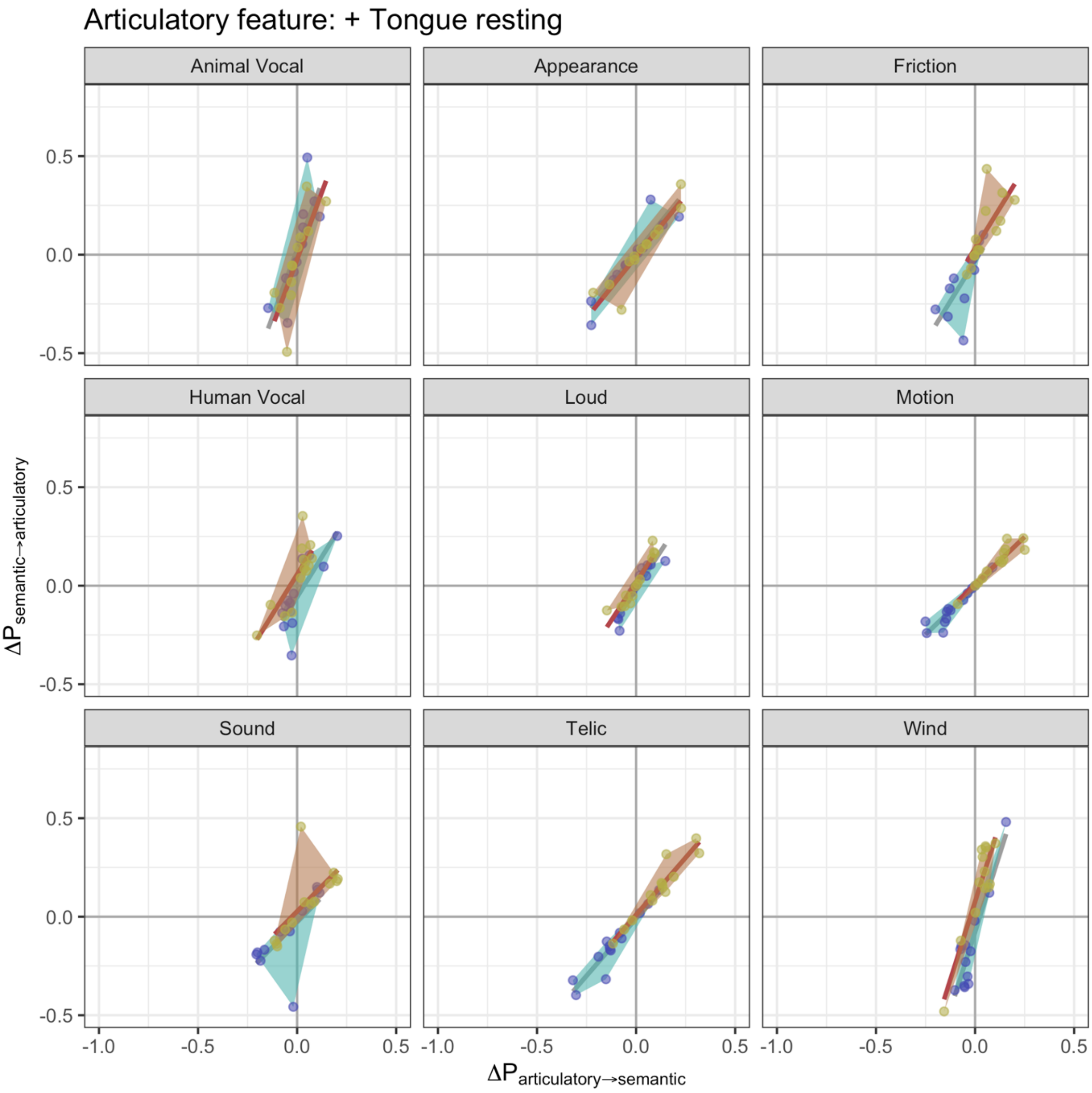


Figure 6: Tongue root

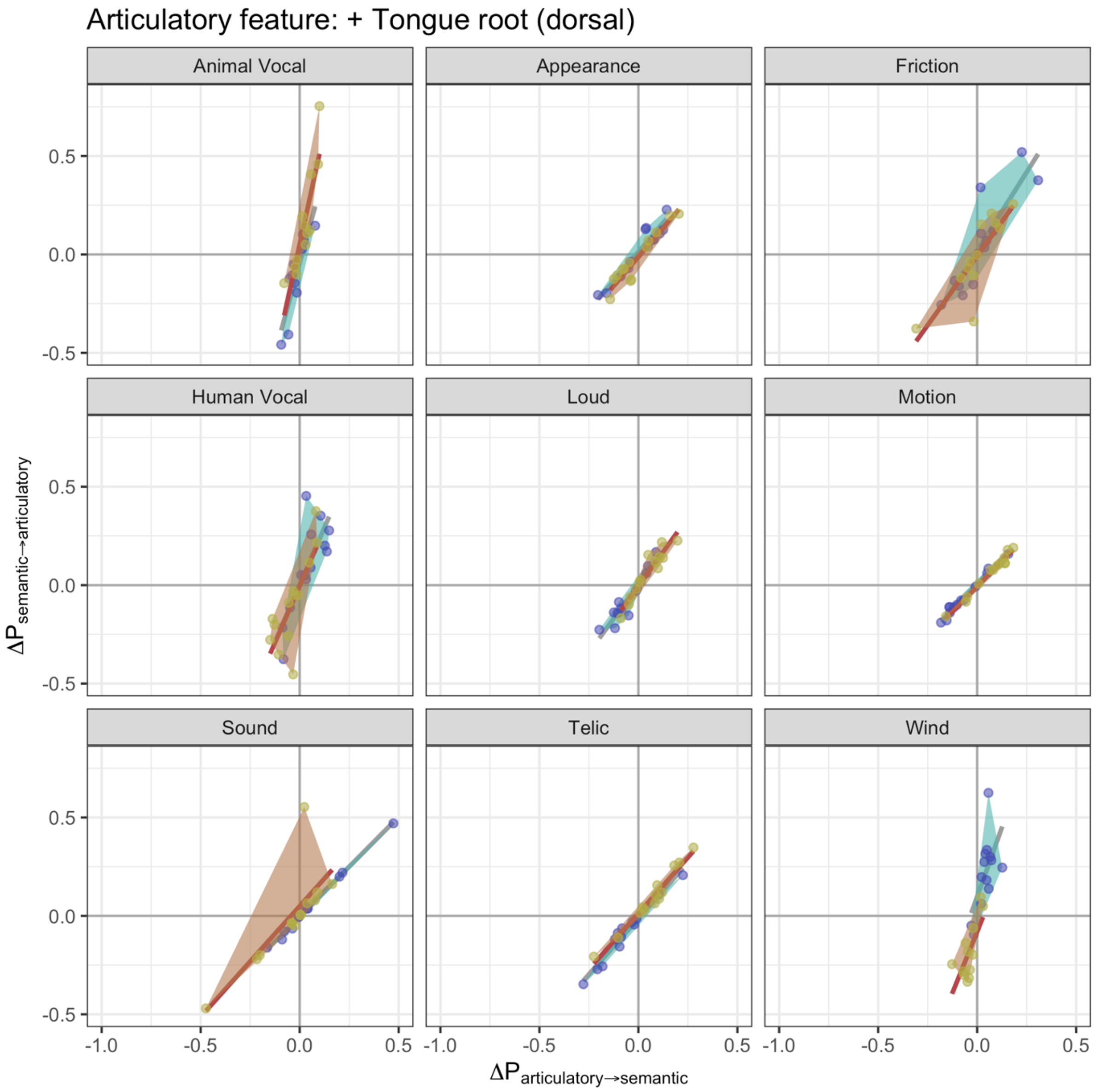


Figure 7: Vocal folds

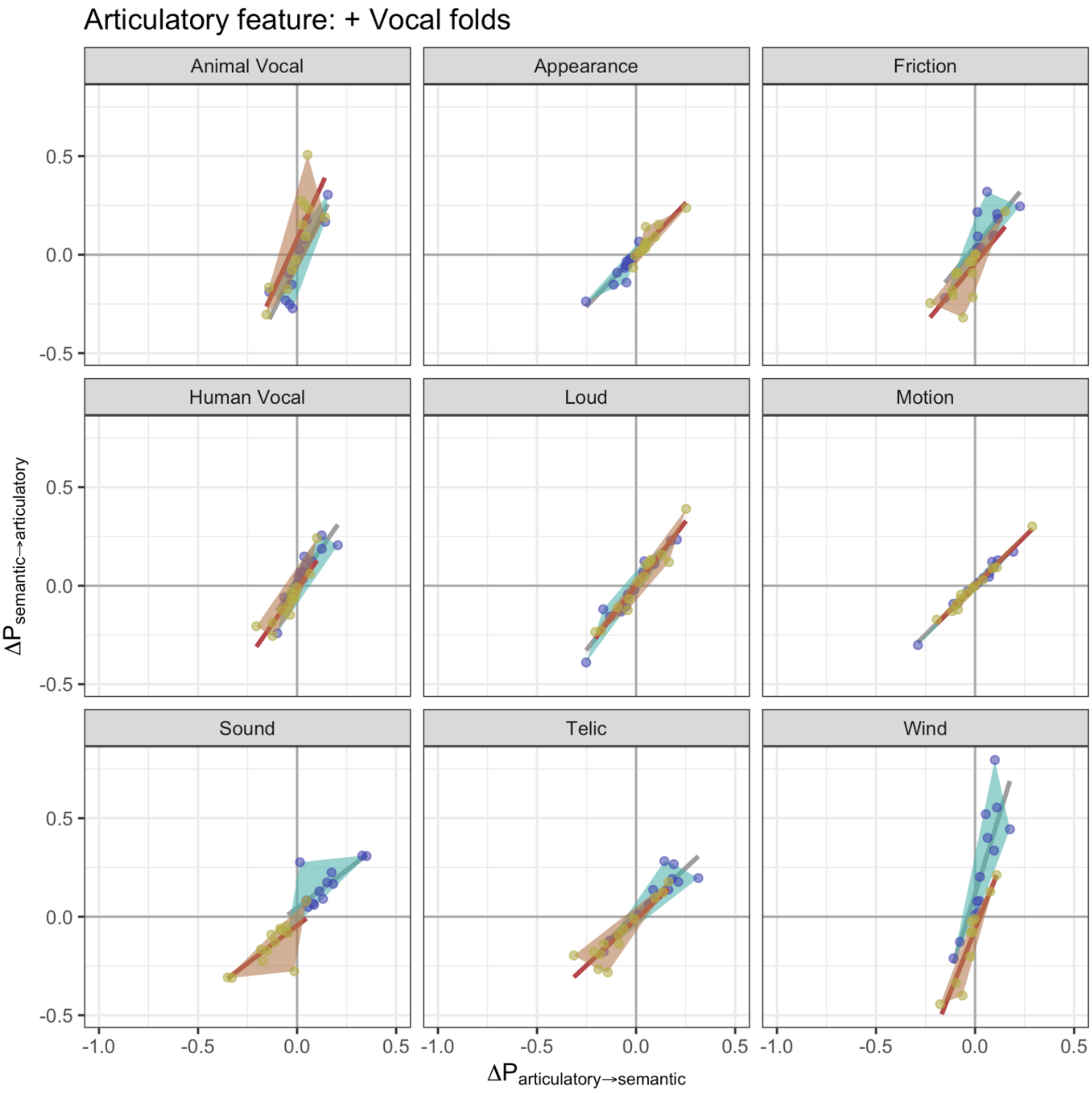


Figure 8: Front vowels

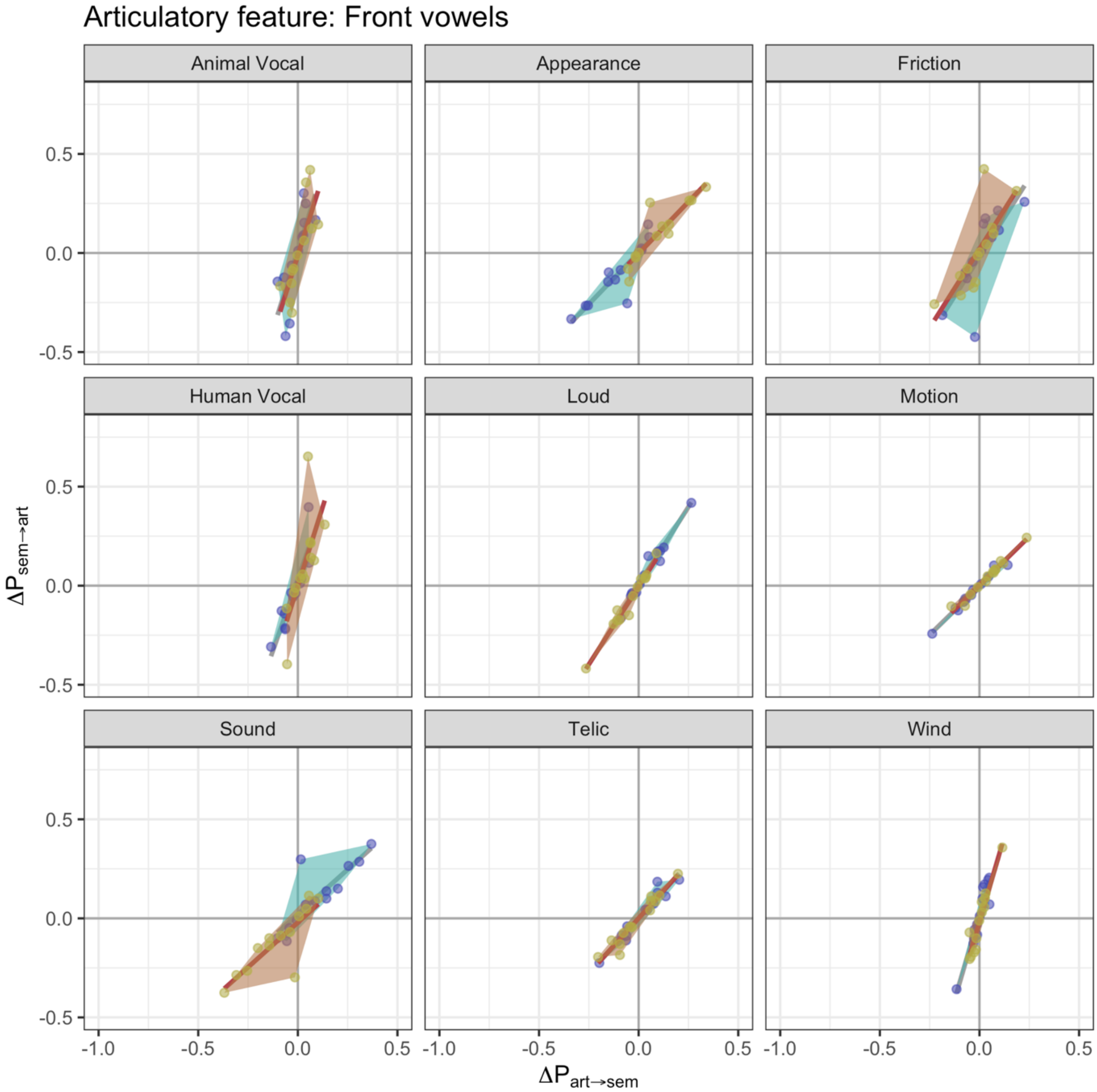


Figure 9: Back vowels

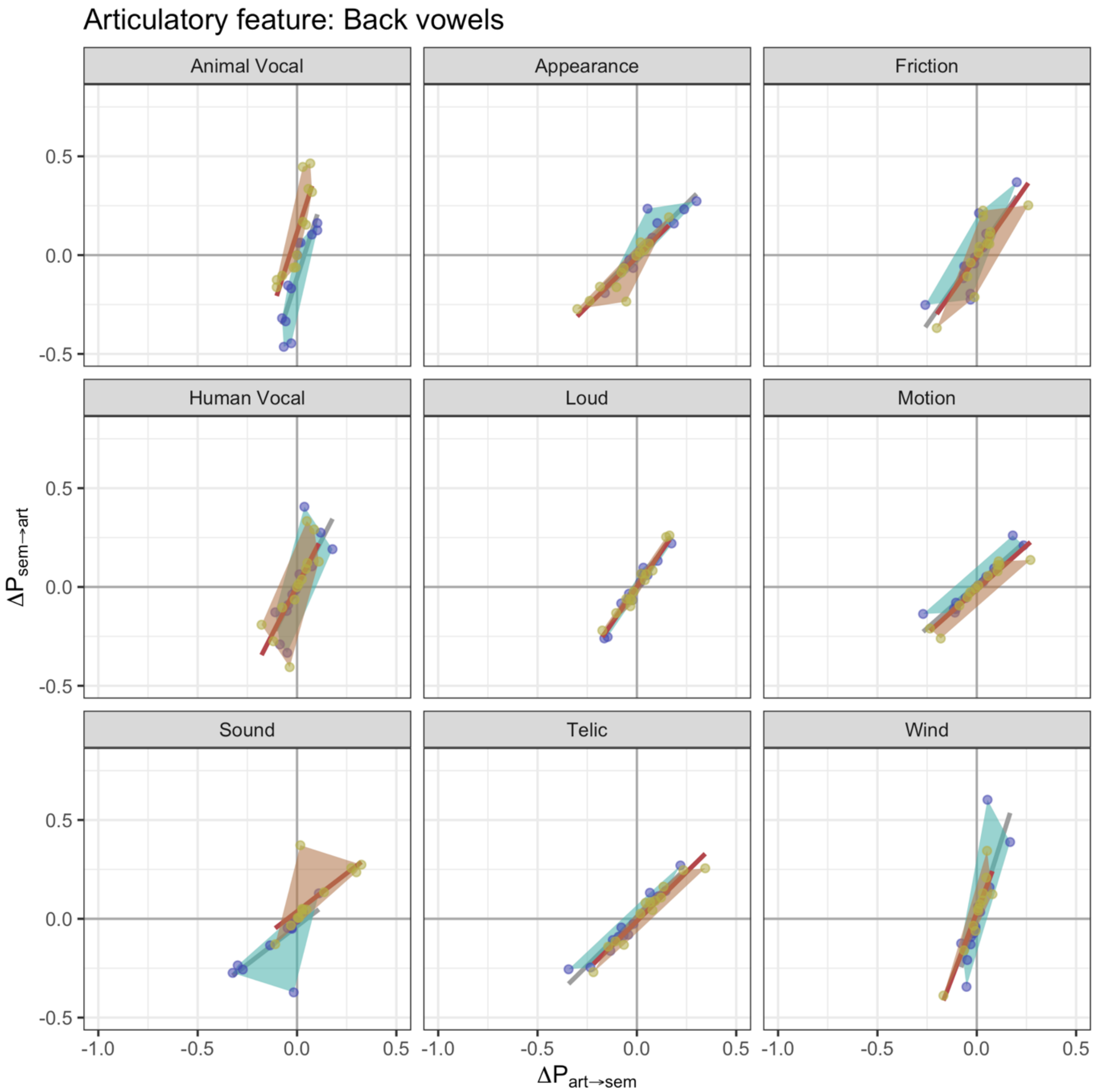


Figure 10: High vowels

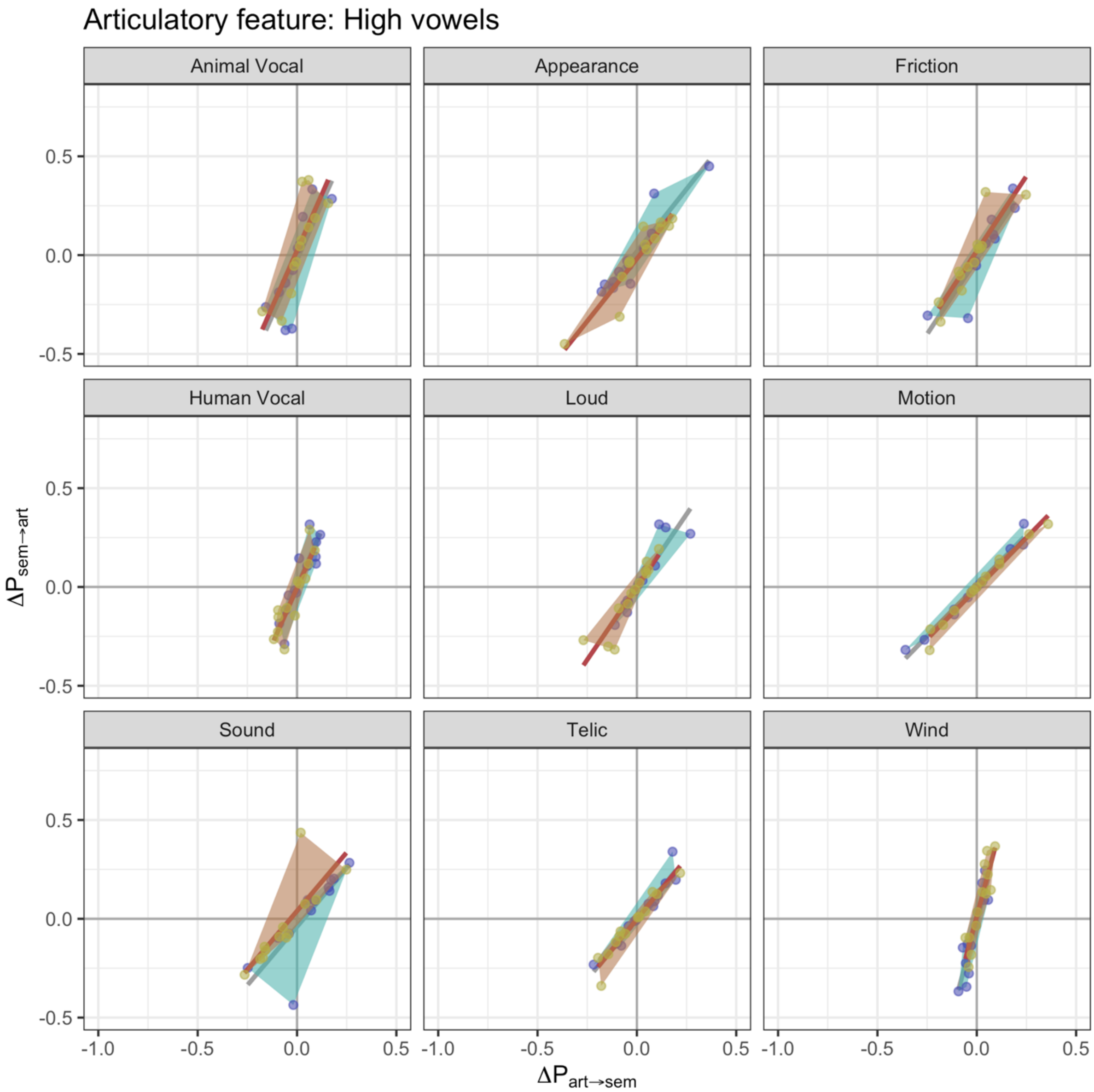


Figure 11: Low vowels

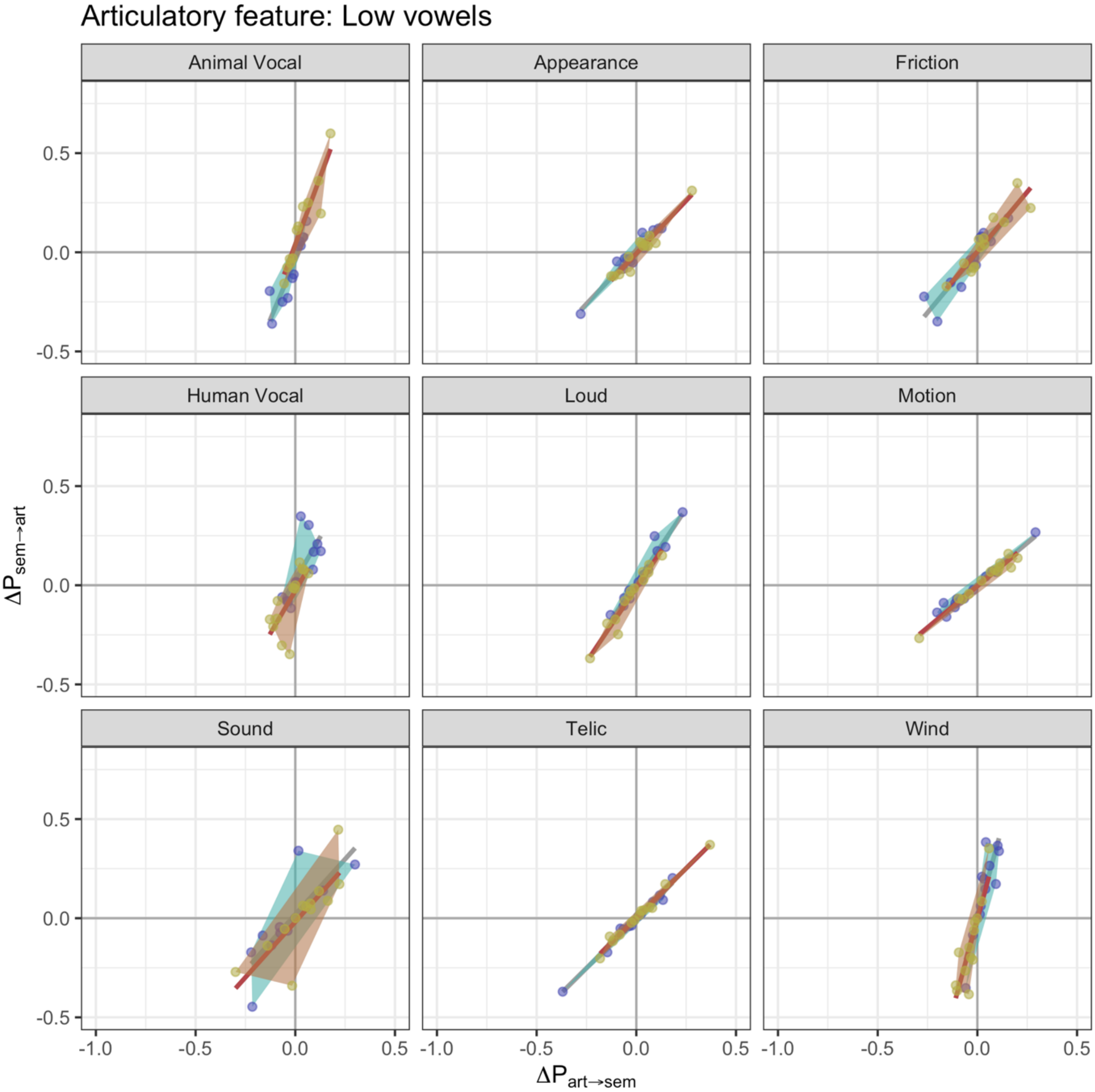


Figure 12: Rounded vowels

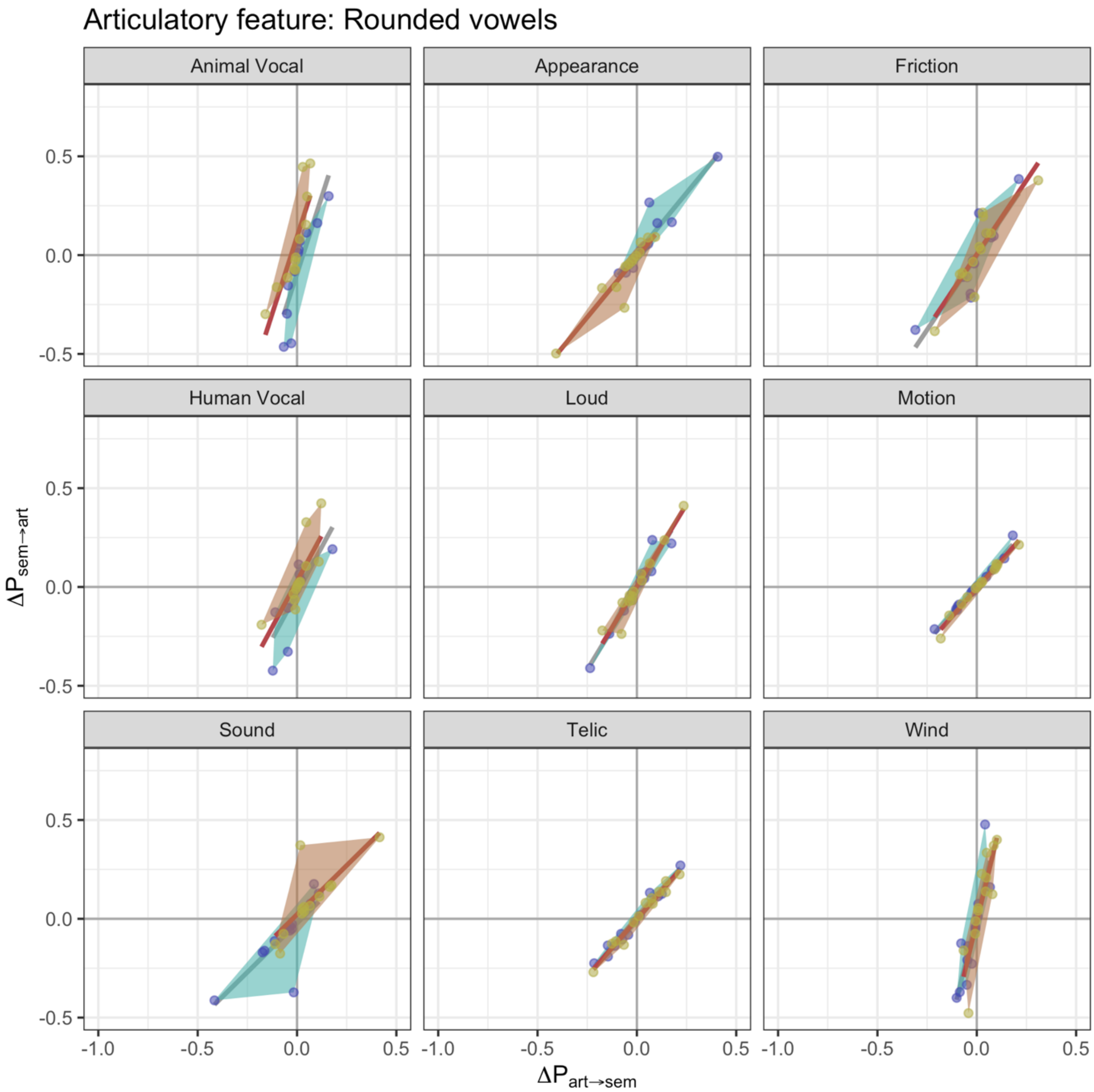
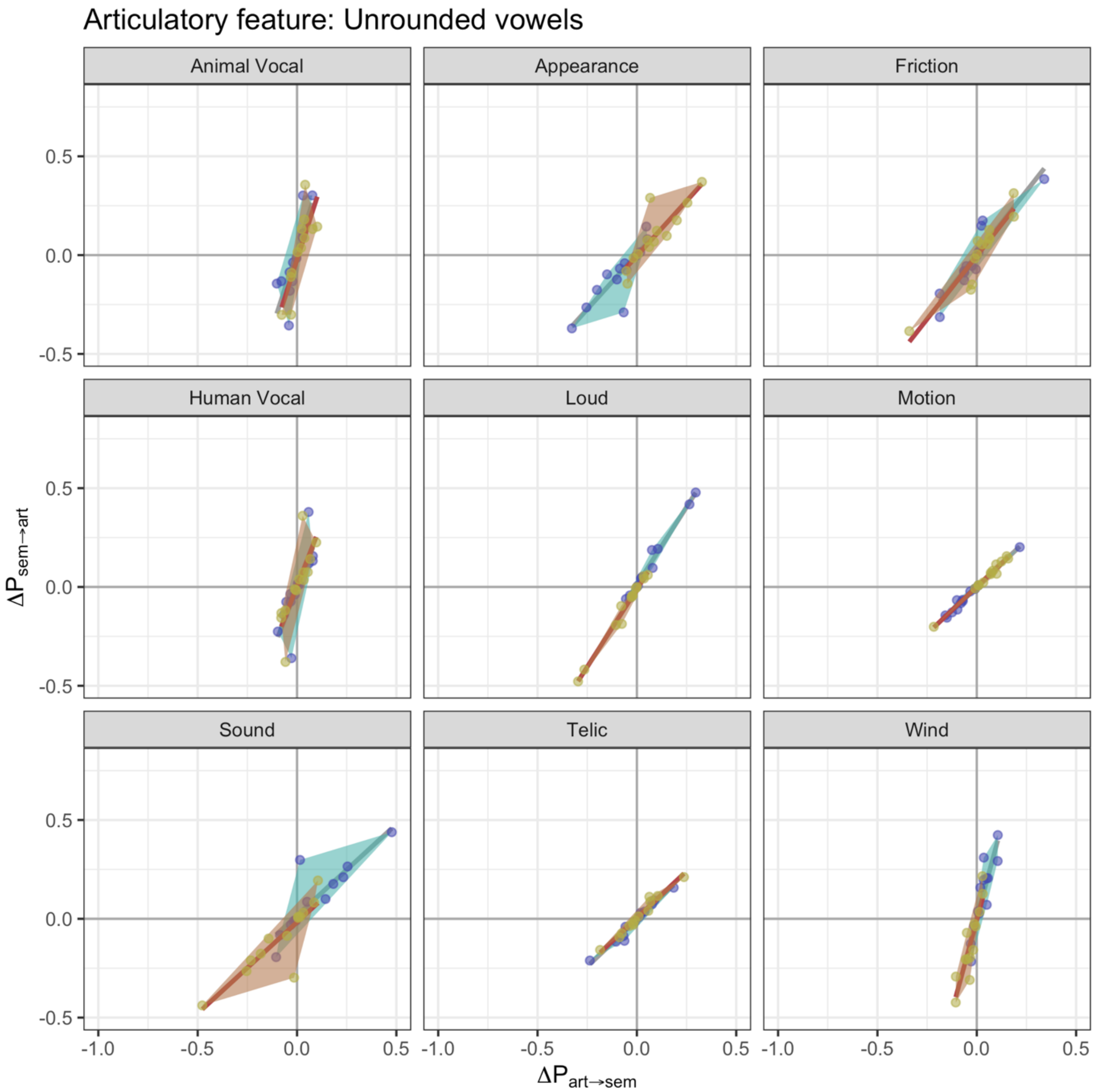


Figure 13: Unrounded vowels



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