The semantic structure of sensory vocabulary in an African language

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Abstract

The widespread occurrence of ideophones, large classes of words specialized in evoking sensory imagery, is little known outside linguistics and anthropology. Ideophones are a common feature in many of the world's languages but are underdeveloped in English and other Indo-European languages. Here we study the meanings of ideophones in Siwu (a Kwa language from Ghana) using a pile-sorting task. The goal was to uncover the underlying structure of the lexical space and to examine the claimed link between ideophones and perception. We found that Siwu ideophones are principally organized around fine-grained aspects of sensory perception, and map onto salient psychophysical dimensions identified in sensory science. The results ratify ideophones as dedicated sensory vocabulary and underline the relevance of ideophones for research on language and perception.

Keywords: semantics; sensory vocabulary; ideophones; sensory perception; mental lexicon

Introduction

Ideophones are marked words that depict sensory imagery, like *sinisinisini* 'closely woven' and *saaa* 'cool sensation' in Siwu, a language of Ghana (Dingemanse, 2011a), or *gorogoro* 'rolling' and *pikapika* 'shiny' in Japanese (Kita, 1997). These highly specific renditions of sensory perceptions — the precise texture of an object felt, the manner of motion of a figure, the visual appearance of a surface — are a common feature of many of the world's languages, with some languages having ideophone inventories numbering into the thousands (Doke & Vilakazi, 1953; Kakehi, Tamori, & Schourup, 1996); but they are underdeveloped in English and other Indo-European languages (Nuckolls, 2004).

The widespread occurrence in natural languages of large classes of words specialized for depicting sensory perception is of significance to research examining the relation between language and perception. Yet, so far, ideophones have been a secret well-kept from cognitive science, studied mostly in lesser known languages by field linguists and anthropologists (Nuckolls, 1996; Voeltz & Kilian-Hatz, 2001). Although the tight link between language and perception in ideophones has long been recognized (Westermann, 1927), the study of their semantic structure has lagged and important questions remain unanswered. What is the link between ideophones and sensory imagery? How should native speakers' knowledge of these sensory words be characterized? What aspects of sensory perception are involved in their representation in the mental lexicon?

Previous semantic classifications of ideophones fail to answer such questions because they usually do not represent native speaker knowledge but reproduce the linguistic categories of the analyst. An example is Alexandre (1966), who classified ideophones in Bulu (a Bantu language from Cameroon) into the five-senses folk model of his own native language: "auditive, visual, tactile, gustative, and olfactive". However, since sensory science shows a larger taxonomy of the senses (Moller, 2002) — including not just the external senses but also interoception (sensitivity to inner physiological conditions) and proprioception (sense of balance and body posture) — we cannot assume the universal relevance of a Western folk model of perception to the classification of ideophones. Other studies of the semantic structure of ideophones have used evidence from lexical collocations, inferring for instance the sensory modes of ideophones from the verbs with which they co-occur (Diffloth, 1976; Awoyale, 1983). Such methods are likely to provide more insight than classifications based on analysts' intuitions, but since the verbs may underspecify the semantic space and since not all ideophones appear in regular collocation with verbs, they may provide an incomplete picture.

Recently, some studies have begun to investigate the semantic structure and sound-symbolic nature of ideophones in Japanese. In a learning study with infants, Imai et al. (2008) built novel words on the template of Japanese ideophones ('mimetics') for manners of motion, and found that these sound-symbolic forms facilitate early verb learning. Osaka (1990) investigated Japanese ideophones of crying, laughing, and talking using a similarity judgment task and found they could be arranged on sensory scales of intensity. In a follow-up study, Osaka and Osaka (2005) focused on laughter ideophones using fMRI, and found they activated striatal reward areas, which they connect to the image-evoking qualities of ideophones. Although interesting in their own right, none of these studies address the domain of ideophones as a whole, nor do they articulate what the principles of organization within this domain might be. Here we study a representative set of ideophones from Siwu, a Kwa language spoken in Ghana, West Africa — a linguistic region known for its extensive ideophone systems (Blench, 2010). The aim was to explore the semantic structure of the domain by capturing native speakers' intuitions.

How might ideophones be organized in the mental lexicon? One possibility is that ideophones are organized in terms of sensory perception (Kita, 1997). Another possibility is that they are organized in terms of semantic dimensions like activity, potency and evaluation, factors

commonly found in multidimensional scaling analyses of affective vocabulary (Osgood, Suci, & Tannenbaum, 1957; Osaka, 1990). A third possibility is that both principles operate, with dimensional and categorical properties working in parallel, perhaps at different levels of granularity. In order to test these hypotheses, we obtained similarity judgments of ideophones using a pile-sorting task.

Another matter of investigation concerns the nature of ideophones as sensory vocabulary. Work in the domain of touch for instance has identified psychophysical dimensions such as rough-smooth, hard-soft, springiness, and firmness (Yoshida, 1968). We considered how the distinctions encoded by ideophones map onto these dimensions, and what this may reveal about ideophones as sensory words and about the construction of sensory vocabularies in general.

Methods

We used a pile-sorting task (Bernard, 2006; Weller & Romney, 1988) to collect similarity data for a frequency-based selection of 58 ideophones. Sorting tasks have been conducted with a wide variety of items, from English nouns (Miller, 1969) and texture words (Bhushan, Rao, & Lohse, 1997) to Navaho food concepts (Perchonock & Werner, 1969). Hierarchical clustering and multidimensional scaling were used to analyze the similarity data to uncover the underlying dimensions used to categorize the items.

Participants

Fourteen participants (ten men), with a mean age of 37.1 years, took part in the sorting task. All were native speakers of Siwu. All were literate in Siwu and in Ewe, a regional language of wider communication.

Materials and design

Ideophones are a class of words distinct from nouns and verbs in the Siwu language. They are formally identifiable in terms of phonotactics, word forms, expressive morphology, syntax, and prosody (Dingemanse, 2011b, pp. 133–160). There are at least 400 ideophones in Siwu. It would clearly be difficult to investigate all ideophones in a single sorting task. A selection of ideophones was therefore made using frequency as a criterion, since this is one measure of the representativeness of the ideophone inventory.

A total of 58 ideophones were selected as follows: a first selection included all ideophones which occurred at least twice in a corpus of five hours of naturally occurring conversations recorded in informal situations (Dingemanse, 2011b). There were 38 such ideophones. A second selection included ideophones which occurred more than three times in responses to elicitation tasks probing different perceptual domains (Majid & Levinson, 2007, 2011). There were 26 such ideophones. Discounting overlaps between the two sets left 20 new ideophones, bringing the total at 58 (Table 1). Each of the 58 ideophones was printed on a 105x35mm card in Siwu orthography.

Procedure

The cards were presented to participants in a 6x10 array arranged according to a fixed random order. While laying the cards out, the ideophones were read out-loud to make sure they were familiar to participants. Three items, *belele, lelele*, and *mɛlɛmɛlɛ*, were not always recognized immediately. When this happened, the ideophones were presented in an example sentence from the conversational corpus. Participants were always able to recognize the words in context.

Instructions were given in Siwu: participants were asked to arrange the cards into groups of similar items. The instruction was to "place together words that belong together, words that are akin" (*atɔ̃mɛ wa lòkote, wa lòɖe manyibi*). Participants were given no explicit criteria for judging similarity and were told they could create as many piles as they liked with as many items per pile as they wished. For three participants who asked for clarification, the sorting procedure was demonstrated using ideophones not included in the set.

Cards were not literally piled but grouped together on a flat surface so all items were kept in view. Participants took between 30 and 70 minutes to group all 58 ideophones. Once participants had completed their groupings, they were debriefed and asked to describe each group.

Table 1: Siwu ideophones used in the sorting task

sinisini closely woven (01), *pɛpɛɛpɛ* precisely (02), *nyanyarĩ* dirty (03), *nyagbalaa* pungent/sour (04), *wɔ̃rãwɔ̃rã* spotted (05), *mɛ̃rɛ̃mɛ̃rɛ̃* tasty (06), *yululu* cold (07), *pɔtɔpɔtɔ* dirty/muddy (08), *pɔkɔsɔɔ* slow (09), *minimini* round (10), *gbiim* sound of explosion (11), *tagbaraa* long (12), *gbegbe* tough (13), *ɖɔbɔrɔɔ* soft (14), *belele* broad and extended (15), *shu* sound of ignition (16), *tititi* big and wide (17), *saaa* cool sensation (18), *dzoroo* far (19), *wosoroo* rough (21), *gɔdɔrɔ* crooked (21), *gbidii* excessive activity (22), *bebrebee* many (23), *mɛlɛmɛlɛ* talkative (24), *pɔlɔpɔlɔ* smooth (25), *pelee* completely (26), *lelele* full to the brim (27), *safaraa* rough/coarse-grained (28), *gelegele* shiny (29), *ɖɛkpɛrɛɛ* fine-grained (30), *kpɔ* sound of impact (31), *kunukunu* completely empty (32), *wĩrĩwĩrĩ* small things dispersed (33), *tsuru* sound of sth. rapidly passing by (34), *teteree* loud (35), *kpãũ* big, enormous (36), *waa* sound of water gushing (37), *fiɛfiɛ* silky (38), *buaa* tasteless (39), *mlamla* quickly (40), *kananaa* silent (41), *krɔ̃krɔ̃* pleasantly smelling (42), *kpɔlɔkpɔlɔ* slippery (43), *gbugburu* tough (44), *gbogboro* tough (45), *kɛkɛi* small (46), *kpinakpina* black (47), *sɔdzɔlɔɔ* oblong (48), *giligili* round (49), *kpokporo* hard (50), *fututu* pure white (51), *miɔmiɔ* pointy (52), *kpoo* silent (53), *wurufuu* fluffy (54), *kpu* sound of impact (55), *yuayua* burning sensation (56), *nyɛ̃kɛ̃nyɛ̃kɛ̃* very sweet (57), *fũɛ̃fũɛ̃* soft-malleable (58)

Results

Dissimilarity matrices were created for each participant and then summed to create the equivalence matrix used for statistical analysis.

Cluster analysis

Hierarchical cluster analysis of the data was performed using the average-linkage-between-groups method, which does not presuppose a particular type of structure in the data. Figure 1 below shows the dendrogram for the cluster analysis.
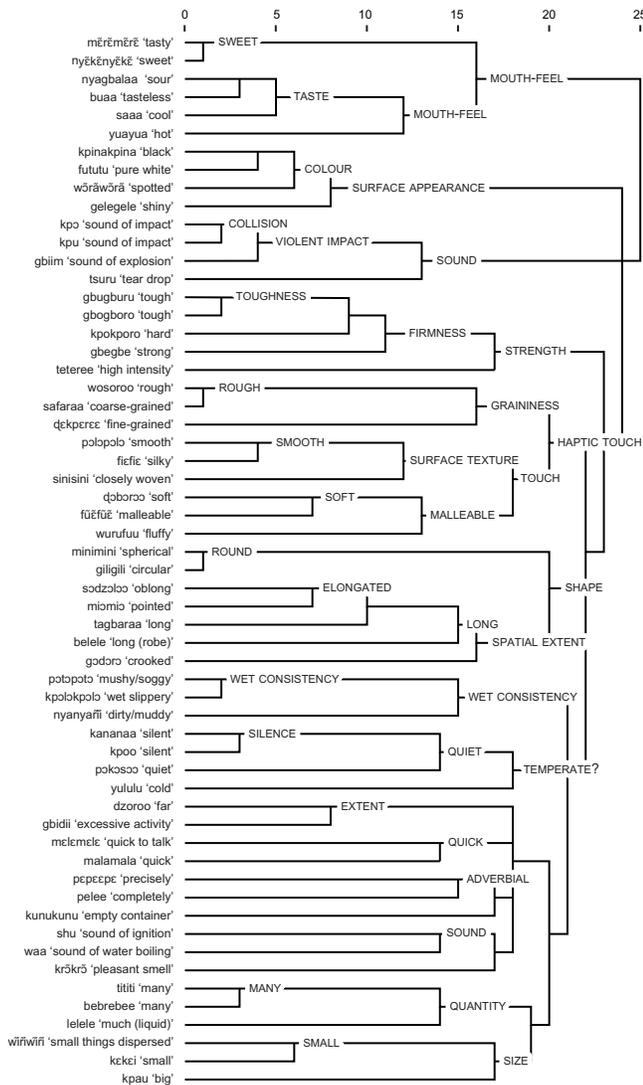

Figure 1: Dendrogram using average linkage

All clusters with a relatively high internal similarity (distances of 10 or lower) can be identified in terms of aspects of sensory perception: SWEET, TASTE, SURFACE APPEARANCE (including COLOUR), VIOLENT IMPACT (including COLLISION), TOUGHNESS, ROUGH, SMOOTH, SOFT, ROUND, ELONGATED, WET CONSISTENCY, SILENCE, EXTENT,

MANY and SMALL. Many of these clusters also join to form coherent higher-order groups. Such higher-order clusters (distances of 20 or lower) include MOUTH-FEEL (merging SWEET and TASTE), SOUND, STRENGTH, HAPTIC TOUCH (merging GRAININESS, SURFACE TEXTURE, and MALLEABLE), SHAPE (merging ROUND and SPATIAL EXTENT), and four clusters that are extended with one member each: WET CONSISTENCY, QUIET, QUANTITY, and SIZE. There is a small residue of words that were rarely grouped with other words, or grouped in very different ways by participants.

The cluster analysis showed two main things. First, it showed that sensory perception is the most salient organizing principle in the domain. This is confirmed by the descriptions given by participants in the debriefing; participants explained their groupings in terms of sensory modalities or acts of sensory perception. Second, it identified a number of coherent sensory categories (and interrelations between categories) at a finer grain than traditional five-senses classifications, providing insight into the different kinds of sensory imagery encoded by ideophones.

Multidimensional scaling

Multidimensional scaling was used to test whether similarity judgments from ideophones were organized in terms of the three well-known dimensions of affective meaning: activity, evaluation and potency (Osgood et al., 1957; Osaka, 1990). A three-dimensional MDS solution showed an RSQ of .80 and a Kruskal stress value of .21 (for 2 dimensions stress was .27, while for 4 dimensions it was only slightly lower at .20). Within the MDS analysis, the major groups identified by the cluster analysis remain largely intact. This lends additional credibility to the sensory categories identified there and to the interpretation that aspects of sensory perception are an important organizing principle in the domain of ideophones.

Does the MDS analysis additionally support a dimensional interpretation? Dimension 1 features TASTE and SHAPE on opposite poles, reinforcing the strong internal coherence of these clusters and their mutual incompatibility in terms of sorting decisions. It does not easily yield a simple dimensional interpretation. Dimension 2 pulls apart a cluster of SOUND ideophones on one side with SURFACE APPEARANCE on the other. While this might be construed as an opposition of events versus states, suggestive of the dimension of activity, it is more plausible that, just as in Dimension 1, these particular clusters are pulled apart simply as a result of their high internal coherence coupled with their semantic incompatibility. The cluster analysis supports this interpretation.

The connotative dimensions of evaluation (good/bad) and potency (strong/weak) do not seem to play a role either. For instance, if evaluation were relevant, we might expect ideophones like *buàà* 'tasteless' and *nyanyarĩĩ* 'dirty' to cluster together, and to be far apart (on one dimension) from ideophones like *mɛ̃rɛ̃mɛ̃rɛ̃* ' delicious' and *nyɛ̃kɛ̃nyɛ̃kɛ̃* 'intensely sweet', but this is not the case. If potency were

relevant we might expect ideophones that differ mainly in terms of intensity to be distant from one another, but they are not.

The nature of the clusters identified both in the cluster analysis and the MDS analysis provides a likely explanation of why the generic connotative dimensions may be absent. The clusters concern aspects of sensory experience from a diverse range of modalities. The sensory modalities differ in discrete, qualitative ways, and this appears to be reflected in our findings.

Discussion

Ideophones as dedicated sensory words

Our results suggest that sensory perception is the main organizing principle in the lexical domain of ideophones, despite other plausible organizing principles. As noted, one might expect generic dimensions commonly found in semantic differential studies to be apparent in this domain. Alternatively, sorting could be done on the basis of other principles, such as word length (grouping *saaa* 'cool sensation' with *kpoo* 'silence' or *tagbaraa* 'long' with *pɔkɔsɔɔ* 'slow') or similarity in sound or spelling (*gìlìgìlì* 'circular' with *gelegele* 'shiny'). Neither the generic dimensions nor the non-semantic features play an appreciable role in the similarity data. This provides independent confirmation of claims made in the anthropological and linguistic literature that ideophones are dedicated sensory words. It also meshes well with empirical findings on the use of ideophones. Data from a corpus of everyday conversations shows that Siwu speakers use ideophones to demonstrate expertise (communicating very precisely about perceptual qualities) and also to share in sensory spectacles in storytelling (Dingemanse, 2011b, pp. 251–300). Both uses rely on the nature of ideophones as marked words that depict sensory imagery.

Previous explorations of the semantic domain of ideophones have mostly relied on informal judgments by the analyst. There is a danger that they do little more than reproduce folk models of the analysts' metalanguage. In contrast, the sorting task allows us to capture a semantic-perceptual space based on native speaker judgments. The fine-grained categories that emerged from the cluster analysis (for instance FIRMNESS, SMOOTHNESS, or SURFACE APPEARANCE) are anchored in the data and agree with speakers' own explanations of their groupings. Therefore they have a different ontological status than coarse-grained labels like Alexandre's (1966) five-sense classification of ideophones. Moreover, the cluster analysis brings to light structures that do not easily fit into such broad classifications: categories that may combine content from multiple modalities (e.g. WET CONSISTENCY, which may combine vision and touch), or categories at a finer grain (as in the subcategories of HAPTIC TOUCH, which include SURFACE TEXTURE, MALLEABILITY and GRAININESS).

Sorting task reproduces psychophysical dimensions

The clusters related to haptic touch provide a useful illustration of the nature of ideophones as sensory vocabulary. Ideophones encoding haptic touch sensations are common in Siwu (Dingemanse, 2011a), and are accordingly well-represented in the frequency-based selection of ideophones used in the sorting task. Independently, we know that Siwu speakers describe tactile stimuli predominantly with ideophones (Dingemanse, 2011b).

Psychophysical research in the domain of haptics has identified a number of salient dimensions of touch perception: rough-smooth, hard-soft, springiness, sticky-slipperiness, and firmness (Yoshida, 1968; Guest et al., 2010; Klatzky, Lederman, & Reed, 1987). The clusters identified through the cluster analysis correspond to these dimensions quite closely: we find ROUGHNESS, SMOOTHNESS, SOFTNESS, MALLEABILITY (the equivalent of springiness), and FIRMNESS. So the distinctions encoded by texture ideophones appear to map well onto the psychophysical properties of the domain.

What is it that makes ideophones good at encoding fine semantic distinctions in ways that reproduce psychophysical dimensions? One reason may be the nature of ideophones as a form class in natural languages. Guest et al. (2010) studied English texture words in order to develop a touch lexicon. They considered a mix of adjectives (rough, soft), verbs (burning, vibrating), terms derived from verbs (sticky, prickly), and source-based adverbs that use simile (sandy, woolly, furry). They found that when the set of words was systematically narrowed to improve the coverage of the touch lexicon, many of the source-based terms were removed, suggesting that abstract (i.e. non-source-based) terms and uniformity in linguistic resources may lead to a better coverage of the semantic-perceptual space. These two features, abstractness of meaning and uniformity of linguistic form, are precisely characteristic of ideophones.

Another reason may be that ideophones are special in their mode of signification. Across languages, ideophones tend to be produced with prosodic foregrounding and expressive features like reduplication and lengthening: signs of the fact that they are depictions, as opposed to descriptions, of sensory imagery (Kunene, 1965; Nuckolls, 1996; Dingemanse, 2011a). Being depictions, ideophones often employ several forms of sound-symbolism or iconicity (Westermann, 1927; Diffloth, 1972; Awoyale, 1983). The iconic use of verbal material, more gradient and less arbitrary than ordinary words, may make ideophones especially fit for representing sensory imagery. Three broad types of iconic mappings have been identified in Siwu ideophones (Dingemanse, 2011c), and similar mappings are found in other ideophone inventories (Tufvesson, 2011). Such iconic mappings allow ideophones to move beyond the imitation of singular events towards perceptual analogies and generalizations of event structure.

The close link between the structural properties of ideophones and the deeply sensory nature of their meanings suggests that ideophones constitute a promising area for research in embodied cognition and sensory science (Barsalou, 1999; Kita, 1997; Akita, 2010).

Organizing principles and level of granularity

Earlier, we mentioned three hypotheses about the organization of ideophones in the mental lexicon: they may be organized in terms of aspects of sensory perception, in terms of generic connotative dimensions, or in terms of a combination of both. Analysis of the similarity judgment data revealed an array of fine-grained sensory categories, suggesting that for this set of ideophones, sensory perception is the most salient organizing principle. Connotative dimensions like activity, potency and evaluation, on the other hand, appear to play no role in the organization of the domain at this level of granularity.

Level of granularity may be a key concept here. The present study took a selection of high frequency ideophones across subdomains. Earlier studies, in contrast, have tended to focus on small subsets of ideophones from circumscribed semantic domains. Osaka (1990) for instance collected similarity data for Japanese ideophones in the semantic domains of talking, crying, and laughing, and found that in each of these domains it was possible to place the ideophones on sensory scales of intensity. This is not surprising: within any sufficiently semantically homogenous cluster of words, the broad connotative dimensions identified by Osgood et al. (1957) will likely play some role (Boster, 2005). This suggests that the third hypothesis, which holds that ideophones are organized by a combination of sensory aspects and generic connotative dimensions, is the most plausible one.

Combining the results from earlier studies and the findings of the present study, we suggest that the word class of ideophones as a whole is organized in terms of aspects of sensory perception, broadly construed; that the semantic distinctions made by ideophones in specific sensory domains may closely follow psychophysical properties; and that connotative dimensions like activity, potency and evaluation may play a role in the internal organization of subsets of sensory words that are sufficiently semantically homogenous.

Conclusions

We have shown that the lexical space of ideophones is organized around aspects of sensory perception. The sensory categories identified through hierarchical cluster analysis are more fine-grained than previous classifications, demonstrating the utility of sorting tasks to capture native speaker intuitions and to map out semantic structures in the mental lexicon. In addition, several of the clusters that emerge from the analysis appear to map neatly onto psychophysical dimensions identified in other research, suggesting that ideophones constitute a sophisticated sensory vocabulary.

Our findings set the scene for cross-linguistic studies of ideophones in the future. Are the same aspects of sensory perception reproduced across languages, suggesting a shared semantic-perceptual space? Do languages impose their own organization on the domain? Does the finer organization of ideophones in specific sensory modalities match relevant psychophysical dimensions, as we see in Siwu ideophones for haptic touch? What are the cognitive consequences of having such dedicated sensory words in terms of mental representation, production and comprehension? And how do the design principles of ideophones relate to their fitness to evoke sensory imagery? The domain of ideophones is ripe for cross-linguistic investigation of these questions.

Ideophones are an example of the kind of linguistic structure that is in danger of being overlooked if the cognitive sciences keep focusing on the very thin slice of human behavior exhibited by Western populations (Henrich, Heine, & Norenzayan, 2010; Majid & Levinson, 2010). Here we hope to have shown that they provide a fruitful avenue to explore how languages can encode sensory perception, and that they are a powerful reminder of the fact that cross-linguistic diversity is an asset rather than an obstacle in the study of language and mind.

References

Akita, K. (2010). An embodied semantic analysis of psychological mimetics in Japanese. *Linguistics*, *48*, 1195–1220. doi:10.1515/LING.2010.039

Alexandre, P. (1966). Préliminaire à une présentation des idéophones Bulu. In J. Lukas (Ed.), *Neue Afrikanische Studien, Hamburger Beiträge zur Afrika-Kunde* (pp. 9–28). Hamburg: Deutsches Institut für Afrika-Forschung.

Awoyale, Y. (1983). On the semantic fields of Yoruba ideophones. *Journal of the Linguistic Association of Nigeria*, *2*, 11–22.

Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, *22*(04), 577–660.

Bernard, H. R. (2006). *Research methods in anthropology*. Rowman Altamira.

Bhushan, N., Rao, A. R., & Lohse, G. L. (1997). The texture lexicon: Understanding the categorization of visual texture terms and their relationship to texture images. *Cognitive Science*, *21*(2), 219–246. doi:10.1016/S0364-0213(99)80023-8

Blench, R. (2010). The sensory world: ideophones in Africa and elsewhere. In A. Storch (Ed.), *Perception of*

the Invisible: Religion, Historical Semantics and the Role of Perceptive Verbs, Sprache und Geschichte in Afrika (pp. 275–296). Cologne: Köppe.

Boster, J. S. (2005). Emotion categories across languages. In C. Lefebvre & H. Cohen (Eds.), *Handbook of Categorization in the Cognitive Sciences* (pp. 187–223). Amsterdam: Elsevier Science.

Diffloth, G. (1972). Notes on expressive meaning. *Chicago Linguistic Society*, *8*, 440–447.

Diffloth, G. (1976). Expressives in Semai. *Oceanic Linguistics Special Publications*, (13), 249–264.

Dingemanse, M. (2011a). Ideophones and the aesthetics of everyday language in a West-African society. *The Senses and Society*, *6*(1), 77–85. doi:10.2752/174589311X12893982233830

Dingemanse, M. (2011b). *The Meaning and Use of Ideophones in Siwu* (PhD dissertation). Radboud University, Nijmegen. Retrieved from http://thesis.ideophone.org/

Dingemanse, M. (2011c). Ezra Pound among the Mawu: Ideophones and Iconicity in Siwu. In P. Michelucci, O. Fischer, & C. Ljungberg (Eds.), *Semblance and Signification*, Iconicity in Language and Literature (pp. 39–54). Amsterdam: John Benjamins.

Doke, C. M., & Vilakazi, B. W. (1953). *Zulu-English Dictionary* (2d ed.). Johannesburg: Witwatersrand University Press.

Guest, S., Dessirier, J. M., Mehrabyan, A., McGlone, F., Essick, G., Gescheider, G., Fontana, A., et al. (2010). The development and validation of sensory and emotional scales of touch perception. *Attention, Perception, & Psychophysics*, *73*(2), 531–550. doi:10.3758/s13414-010-0037-y

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The Weirdest People in the World? *Behavioral and Brain Sciences*, *33*(2-3), 61–83. doi:10.1017/S0140525X0999152X

Imai, M., Kita, S., Nagumo, M., & Okada, H. (2008). Sound symbolism facilitates early verb learning. *Cognition*, *109*(1), 54–65. doi:10.1016/j.cognition.2008.07.015

Kakehi, H., Tamori, I., & Schourup, L. (1996). *Dictionary of Iconic Expressions in Japanese*. Berlin/New York: Mouton.

Kita, S. (1997). Two-dimensional semantic analysis of Japanese mimetics. *Linguistics*, *35*, 379–415.

Klatzky, R. L., Lederman, S. J., & Reed, C. (1987). There's more to touch than meets the eye: The salience of object attributes for haptics with and without vision. *Journal of Experimental Psychology: General*, *116*, 356–369. doi:10.1037/0096-3445.116.4.356

Kunene, D. P. (1965). The ideophone in Southern Sotho. *Journal of African Languages*, *4*, 19–39.

Majid, A., & Levinson, S. C. (2007). Language of perception: overview of field tasks. In A. Majid (Ed.), *Field Manual Volume 10* (pp. 8–9). Nijmegen: Max Planck Institute for Psycholinguistics. Retrieved from http://fieldmanuals.mpi.nl/volumes/2007/language-of-perception-overview/

Majid, A., & Levinson, S. C. (2010). WEIRD languages have misled us too. *Behavioral and Brain Sciences*.

Majid, A., & Levinson, S. C. (2011). The Senses in Language and Culture. *The Senses and Society*, *6*(1), 5–18.

Miller, G. A. (1969). A psychological method to investigate verbal concepts. *Journal of Mathematical Psychology*, *6*(2), 169–191. doi:10.1016/0022-2496(69)90001-7

Moller, A. R. (2002). *Sensory systems : anatomy and physiology*. San Diego, Calif.; London: Academic.

Nuckolls, J. B. (1996). *Sounds Like Life: Sound-Symbolic Grammar, Performance, and Cognition in Pastaza Quechua*. New York: Oxford University Press.

Nuckolls, J. B. (2004). To be or to be not ideophonically impoverished. In Wai Fong Chiang, E. Chun, L. Mahalingappa, & S. Mehus (Eds.), *SALSA XI: Proceedings of the Eleventh Annual Symposium about Language and Society*, Texas Linguistic Forum (pp. 131–142). Austin.

Osaka, N. (1990). Multidimensional analysis of onomatopoeia: A note to make sensory scale from words. *Studia phonologica*, *24*, 25–33.

Osaka, N., & Osaka, M. (2005). Striatal reward areas activated by implicit laughter induced by mimic words in humans: a functional magnetic resonance imaging study. *Neuroreport*, *16*(15), 1621–1624.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The Measurement of Meaning*. Urbana: University of Illinois Press.

Perchonock, N., & Werner, O. (1969). Navaho systems of classification: some implications for ethnoscience. *Ethnology*, *8*(3), 229–242.

Tufvesson, S. (2011). Analogy-making in the Semai Sensory World. *The Senses and Society*, *6*(1), 86–95. doi:10.2752/174589311X12893982233876

Voeltz, F. K. E., & Kilian-Hatz, C. (Eds.). (2001). *Ideophones*. Typological Studies in Language. Amsterdam: John Benjamins.

Weller, S. C., & Romney, A. K. (1988). *Systematic data collection*. Newbury Park, CA: Sage Publications.

Westermann, D. H. (1927). Laut, Ton und Sinn in westafrikanischen Sudansprachen. In F. Boas (Ed.), *Festschrift Meinhof* (pp. 315–328). Hamburg: L. Friederichsen.

Yoshida, M. (1968). Dimensions of tactual impressions (1). *Japanese Psychological Research*, *10*(4), 123–137.