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Vision dominates in perceptual language: English sensory vocabulary is optimized for usage

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ABSTRACT

Researchers have suggested that the vocabularies of languages are oriented towards the communicative needs of language users. Here, we provide evidence demonstrating that the higher frequency of visual words in a large variety of English corpora is reflected in greater lexical differentiation—a greater number of unique words—for the visual domain in the English lexicon. In comparison, sensory modalities that are less frequently talked about, particularly taste and smell, show less lexical differentiation. In addition, we show that even though sensory language can be expected to change across historical time and between contexts of use (e.g., spoken language versus fiction), the pattern of visual dominance is a stable property of the English language. Thus, we show that across the board, precisely those semantic domains that are more frequently talked about are also more lexically differentiated, for perceptual experiences. This correlation between type and token frequencies suggests that the sensory lexicon of English is geared towards communicative efficiency.

1. Introduction

The vocabularies of languages appear to be geared towards the communicative needs of their speakers. In the domain of color, for example, Berlin and Kay (1969) famously suggested that languages only have a small set of color words that tend to cluster around similar perceptual foci across languages (see also Cook, Kay, & Regier, 2005). Indeed, recent evidence indicates that basic color terms are not randomly distributed across the color spectrum, but rather partition it in a way that is most efficient to refer to colors in human environments. Griffin (2006) showed computationally that basic color terms such as *red*, *blue* and *green* produce better color categorization performance of natural images than other color categorization systems, while Yendrikhovskij (2001) found that natural image statistics reveal color clusters closely aligned with the color terms frequently found in the world's languages. Similarly, Gibson et al. (2017) showed speakers more commonly talk about warm-colored objects in the world, and consequently languages have more dedicated means to talk about 'warm' colors.

Similar adaptations to language use have been demonstrated in other conceptual domains. One linguistic "signature" of being geared towards efficiency in usage is when so-called "type" and "token" frequencies are correlated with each other (e.g., Regier, Carstensen, & Kemp, 2016). Type frequencies measure the number of unique word types within a given domain, i.e., how lexically differentiated a domain is. Token frequencies measure how frequently each unique word type is used. A positive correlation between type and token frequencies across conceptual domains indicates that the lexicon of a language has more words precisely for those concepts that speakers also talk about more frequently. Moreover, a correlation between type and token frequency is doubly impressive because if a conceptual domain is broken up into more distinct word types, we may expect each type to be less frequent. If, however, type and token frequencies are positively correlated, then this indicates an even greater need to talk about a given conceptual domain. Regier et al. (2016) showed that languages spoken in relatively colder climates are more likely to distinguish between the concepts 'ice' and 'snow' (type frequencies), and they also more frequently refer to these concepts (token frequencies of both types). On the other hand, languages spoken in warmer climates are more likely to collapse the ice/snow distinction. Similarly, Warriner and Kuperman (2015) showed that English speakers use positive words such as *pleasure* more frequently than negative words such as *disgust*, and they similarly showed that the English language also has more distinct positive word types in the lexicon.

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These studies demonstrate how the lexicons of English and other languages are geared towards communicating effectively about various conceptual domains, such as color and ice/snow. Here, we investigate how English is optimized for communicating about our sensory experience more generally. In particular, evidence from different disciplines, including cognitive psychology (reviewed in Stokes & Biggs, 2015), anthropology (e.g., Classen, 1993, 1997), linguistics (e.g., Levinson & Majid, 2014; Viberg, 1983), and philosophy (Keller, 2016; Korsmeyer, 1999), suggests that vision is the most important sensory modality, at least in Western cultures (Majid et al., in press). Our study examines whether the structure of the English lexicon and the way it is used corresponds to this visual dominance in perception. Does English feature more words for visual concepts compared to the other senses? And do speakers use these words more frequently?

1.1. Visual dominance in perception

The hypothesis that English is optimized for the communication of visual concepts is based on multiple strands of evidence which together suggest that vision is the dominant human sense. In particular, demonstrations of "visual dominance" in perception (for review see Stokes & Biggs, 2015) are persuasive. For example, in the so-called "ventriloquist effect", the location where something is seen overrides the location where something is heard (Alais & Burr, 2004; Pick, Warren, & Hay, 1969; Welch & Warren, 1980). Additionally, the influence of vision extends to the other senses: How something is seen modulates how something is felt more strongly than the other way around (Hay & Pick, 1966; Rock & Victor, 1964), and vision can also influence how something is tasted or smelled (Hidaka & Shimoda, 2014; Morrot, Brochet, & Dubourdieu, 2001; Shermer & Levitan, 2014). These studies demonstrate the capacity of vision to profoundly affect how the other sensory modalities are perceived, more so than the reverse. Moreover, when people integrate information across senses, visual information is often privileged over other sensory modalities (e.g., Spence, Parise, & Chen, 2012). People also find it easier to perform mental imagery in the visual modality than in other modalities (e.g., Brower, 1947; Kosslyn, Seger, Pani, & Hillger, 1990). Finally, visual dominance is arguably indicated in the anatomy of the human brain, with studies suggesting that vision occupies the largest part of cortex (Drury et al., 1996; Palmer, 1999).

1.2. Visual dominance reflected in language

Given the dominance of vision in perception, the hypothesis that languages adapt to communicative need predicts that languages should be geared towards talking about visual concepts, compared to the other senses. Indeed, in linguistics, the idea that language may exhibit visual dominance is not a new one (see Levinson & Majid, 2014), with Buck (1949: chap. 15) already noting in his Indo-European dictionary that for English verbs, there are more agency distinctions for the visual (*to see, to look, to look at*) and auditory modality (*to hear, to sound, to listen*) than for the gustatory and olfactory modalities. For example, an English speaker lexically distinguishes between *it looked good* and *she saw it*, but not between *it smelled good* and *she smelled it*. This work was extended by Viberg (1983), who demonstrated that across several languages and language families, verbs of visual perception are indeed more lexically differentiated than perceptual verbs for other sensory modalities (see also Evans & Wilkins, 2000). Other researchers have argued that visual verbs are also more likely to be semantically extended compared to verbs for the other sensory modalities, as when speakers say *I see you* to mean 'I understand you' (see Caplan, 1973; Matlock, 1989; Evans & Wilkins, 2000; Sweetser, 1990; Ibarretxe-Antuñano, 2008). In addition, Viberg (1993) showed that visual verbs in English have higher token frequencies in text corpora, a finding that was extended to everyday conversation across 13 different languages by San Roque et al. (2015).

1.3. Current study

These studies are consistent with the hypothesis that visual dominance in perception and human behavior corresponds to visual dominance in the vocabularies of English and other languages, such that there are a greater array of verbs for vision-related concepts. Moreover, speakers use these different verbs more frequently than those of the other, less differentiated senses. But just how deep and pervasive is the perceptual dominance of vision in language?

In the current study, we tested whether visual dominance in English extends across the sensory vocabulary, including adjectives such as *blue*, *soft* and *fragrant*, and nouns such as *music* and *reflection*. Our analysis also spans multisensory words such as *large* and *harsh,* which clearly describe perceptual content, but not perceptual content exclusive to just one modality (see Lynott & Connell, 2009; Winter, 2016b: chap. 2). We also examined whether visual dominance was robust across registers—such as fiction or academic writing—and whether the pattern is stable across time. Across our analyses, we investigated both unique types of words, as well as their token frequencies. Our results show—across lexical class, register, and historical time—that the English language contains more visual words, and that speakers use these words more frequently. In comparison, English features fewer distinct taste and smell words, and speakers tend to verbalize taste, and particularly smell, concepts less frequently. The fact that precisely those sensory modalities that are more frequently talked about also have more semantic distinctions supports the view that English perceptual vocabulary is adapted towards the communicative needs of its speakers.

2. Methods

2.1. Using modality norms to characterize sensory modalities

We utilized native speaker ratings to quantify the degree to which a word was visual, auditory, tactile, gustatory or olfactory. Such "modality norms" have been collected by many researchers (including Lynott & Connell, 2009, 2013; Speed & Majid, 2017; van Dantzig, Cowell, Zeelenberg, & Pecher, 2011; Winter, 2016a). The basic task was innovated by Lynott and Connell (2009), who asked 55 native speakers of British English to rate a set of 423 property words (adjectives) on a scale from 0 to 5 on each of the five sensory modalities. The word *yellow*, for example, received an average rating of 4.9 on its "visual strength", compared to ratings of 0, 0.2, 0.1 and 0.1 for tactile, auditory, gustatory and olfactory strength respectively. The norms can be considered "well-calibrated" with respect to studying the intersection of language and perception because they have been shown to correspond meaningfully to a number of behavioral measures (Connell & Lynott, 2010, 2012, 2014, 2016; Speed & Majid, 2017; van Dantzig et al., 2011) and linguistic patterns (Louwerse & Connell, 2011; Winter, 2016a, 2016b; Winter, Perlman, Perry, & Lupyan, 2017).

Here, we use the adjective norms collected by Lynott and Connell (2009) (N = 423), the noun norms by Lynott and Connell (2013) (N = 400) and the verb norms by Winter (2016a) (N = 300). Our total data set comprises 1123 words. For ease of discussion, we focus our analyses of token frequencies on the SUBTLEX corpus of movie subtitles (see Brysbaert & New, 2009 for arguments in favor of using this corpus). However, we replicate our analyses with several old and new frequency lists that are commonly used in psycholinguistics and linguistics (several are taken from the English Lexicon Project, Balota et al., 2007). These corpus-based word frequency lists include Kučera and Francis (Kučera & Francis, 1967), the Hyperspace Analogue of Language (HAL, Lund & Burgess, 1996), SUBTLEX-UK (Keuleers, Lacey, Rastle, & Brysbaert, 2012), CELEX (Baayen, Piepenbrock, & van Rijn, 1993) and the British National Corpus (Leech, 1992). These different corpora contain texts from multiple time spans and feature different linguistic registers and different dialects (both British English and American