Cognition 136 (2015) 186–195

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

What is the link between synaesthesia and sound symbolism?

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ARTICLE INFO

Article history:
Received 17 December 2012
Revised 4 November 2014
Accepted 17 November 2014

Keywords:
Sound symbolism
Iconicity
Synaesthesia
Synesthesia
Mechanical Turk
MTurk

ABSTRACT

Sound symbolism is a property of certain words which have a direct link between their phonological form and their semantic meaning. In certain instances, sound symbolism can allow non-native speakers to understand the meanings of etymologically unfamiliar foreign words, although the mechanisms driving this are not well understood. We examined whether sound symbolism might be mediated by the same types of cross-modal processes that typify synaesthetic experiences. Synaesthesia is an inherited condition in which sensory or cognitive stimuli (e.g., sounds, words) cause additional, unusual cross-modal percepts (e.g., sounds trigger colours, words trigger tastes). Synaesthesia may be an exaggeration of normal cross-modal processing, and if so, there may be a link between synaesthesia and the type of cross-modality inherent in sound symbolism. To test this we predicted that synaesthetes would have superior understanding of unfamiliar (sound symbolic) foreign words. In our study, 19 grapheme-colour synaesthetes and 57 non-synaesthete controls were presented with 400 adjectives from 10 unfamiliar languages and were asked to guess the meaning of each word in a two-alternative forced-choice task. Both groups showed superior understanding compared to chance levels, but synaesthetes significantly outperformed controls. This heightened ability suggests that sound symbolism may rely on the types of cross-modal integration that drive synaesthetes' unusual experiences. It also suggests that synaesthesia endows or co-occurs with heightened multi-modal skills, and that this can arise in domains unrelated to the specific form of synaesthesia.

1. Introduction

Sound symbolism is a property of certain words which have a direct link between their phonological form and their semantic meaning. There is a rich history of research into sound symbolism, starting perhaps with Köhler (1929), who found that participants shared preferences for the naming of novel objects: they reliably matched nonwords such as *baluma* to rounded shapes, and nonwords such as *takete* to angular shapes. This finding has been extended by other authors, who suggest this shows a non-arbitrary relationship between sound and meaning: that there is something 'rounded' about the sounds comprising *baluma* and something 'angular' about *takete* (Davis, 1961; Maurer, Pathman, & Mondloch, 2006; Ramachandran & Hubbard, 2001). Sound symbolism also occurs in the real words of natural languages. English speakers are able to guess the meanings of foreign dimensional adjectives (e.g., meaning: *big*/*small*, *round*/*pointy*,

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http://dx.doi.org/10.1016/j.cognition.2014.11.013
0010-0277/

fast/*slow*, etc.) at above-chance levels, for words in Albanian, Dutch, Gujarati, Indonesian, Korean, Mandarin, Romanian, Tamil, Turkish, Yoruba, Chinese, Czech, Hindi, Japanese, and Tahitian (Brown, Black, & Horowitz, 1955; DeFife, Nygaard, & Namy, 2014; Klank, Huang, & Johnson, 1971; Kunihira, 1971). This again suggests some inherent clues to meaning in the form of those words. Berlin (1994) demonstrated the presence of sound symbolism beyond dimensional adjectives, in a study investigating bird and fish names in the Peruvian language Huambisa; native English speakers correctly categorised bird names at rates significantly higher than chance (Berlin, 1994). An acoustic analysis of these words revealed that high frequency segments characterised bird names while low frequency segments characterised fish names. This demonstrates that the Huambisa language contains sound symbolic phonological patterns to distinguish bird and fish names, and furthermore, that native English speakers are capable of decoding these patterns. Farmer, Christiansen, and Monaghan (2006) also demonstrated the presence of sound symbolism within English, finding that English nouns and verbs have category-typical phonological properties and, furthermore, that listeners are sensitive to these properties during on-line processing tasks. The cross-linguistic presence of sound-to-meaning mappings, and the ability to deduce sound-to-meaning mappings in other languages, suggests that vocabulary is not arbitrarily assigned (or processed) and that it may be guided by shared cross-modal mechanisms. Nonetheless, the exact nature of these mechanisms is not well understood.

In the present study, we sought a better understanding of sound symbolism by comparison with a case of extreme cross-modal processing known as *synaesthesia*. For people with synaesthesia, sensory or cognitive stimuli (e.g., written words) induce the experience of unusual additional percepts, either in the same modality (e.g., the colour red) or in a different modality (e.g., the taste of oranges). *Grapheme-colour synaesthetes*, for example, experience colours triggered by reading, hearing, saying or thinking about graphemes (e.g., *a* = red; e.g., Simner, Glover, & Mowat, 2006). The condition has a genetic basis (Asher et al., 2009; Tomson et al., 2011) and is typified by anatomical differences including altered white-matter coherence (e.g., Rouw & Scholte, 2007) and grey matter volume (Weiss & Fink, 2009). Synaesthesia is thought to arise from either excess cortical connections or disinhibition of existing circuits (or both; see Bargary & Mitchell, 2008, for review). In behavioural terms, synaesthesia causes a type of unusual 'cross-talk' between modalities, and in the present study we ask whether a comparable type of cross-talk might also underlie normal linguistic sound symbolism.

It has been suggested that synaesthesia represents an enhancement or explicit manifestation of latent implicit cross-modal associations found in the general population (see below). Since sound symbolism is a case of cross-modal association, the enhanced cross-modal state of synaesthetes might afford synaesthetes superior abilities in sound symbolic tasks. In our study we asked synaesthetes and controls to guess the meanings of foreign words in languages they do not speak. If synaesthetes show superior understanding of sound symbolic meanings this would be the first explicit link between synaesthetic and sound symbolic cognition, and would provide a novel way to frame this relatively poorly understood area of language processing. Such a finding would also shed light on the unusual condition of synaesthesia, per se, by showing that synaesthetes might be unusually skilled in cross-modal tasks entirely unrelated to their synaesthesia.

A possible link between synaesthetic and 'normal' processing is already motivated by prior studies. Although synaesthetic experiences are superficially idiosyncratic from one synaesthete to the next (e.g., the letter *a* might be red for one synaesthete but green for another), many types of synaesthesia often reflect patterns found intuitively in the general population (see Simner, 2013 for review). Sound-colour synaesthetes, for example, tend to 'see' higher pitch sounds as lighter colours, and nonsynaesthetes tend to favour this same mapping by intuition, in forced-choice cross-sensory association tasks (Marks, 1974; Ward, Huckstep, & Tsakanikos, 2006). Many forms of synaesthesia follow this same general principle of reflecting nonsynaesthetes' implicit associations (e.g., Cytowic & Wood, 1982; Marks, 1974, 1987; Simner & Ludwig, 2012; Simner et al., 2005; Smilek, Carriere, Dixon, & Merikle, 2007; Ward et al., 2006). These common patterns across synaesthetes and nonsynaesthetes suggest that synaesthesia might be an exaggeration or heightened awareness of cross-modal associations present in the general population. If synaesthesia is a superior manifestation of normal cross-modality, this may allow synaesthetes to perform better than nonsynaesthetes in a range of cross-modal tasks, including perhaps, those relating to sound symbolism.

Evidence for synaesthetes' superior performance in other areas of cross-modality has been demonstrated by Brang, Williams, and Ramachandran (2011). They showed that grapheme-colour synaesthetes have a heightened sensitivity to cross-modal associations in a double-flash illusion task: participants reported the number of visual flashes perceived (1 or 2) in conditions where the flashes were accompanied by either the same number of auditory beeps, or a different number. Synaesthetes were significantly less accurate in the incongruent condition (1 flash, 2 beeps) compared to nonsynaesthetes, suggesting they more strongly integrated the visual and auditory signals. In a second task, synaesthetes benefited more from bimodal stimuli than nonsynaesthetes when detecting both unimodal (auditory beep or visual flash) or bimodal stimuli. Since grapheme-colour synaesthetes do not experience synaesthesia for flashes or beeps, these findings show that their cross-modal skills extend to stimuli beyond those involved in their specific type of synaesthesia (Brang et al., 2011; but see Neufeld, Sinke, Zedler, Emrich, & Szycik, 2012, for evidence that older synaesthetes may lose this advantage). Although synaesthetes have increased multimodal integration, it is not known if this potential advantage could also be found in 'higher level' cognitive cross-modal processing, such as the language processing of sound symbolism.