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Interoception: The Forgotten Modality in Perceptual Grounding of Concepts

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Concepts are the basis of the human cognitive system, and the question of what constitutes the content of these mental representations has long occupied the cognitive sciences. Work in psychology, linguistics and cognitive neuroscience has converged on the idea that we develop our conceptual representations through our perception of and interaction with our environment. To date, such research has typically restricted consideration to the perceptual modalities of vision, touch, sound, taste, and smell. However, there is another major modality of perceptual information that is distinct from these traditional five senses; that is, interoception, or sensations within the body. In this paper, we explore the role of interoception in the perceptual grounding of concepts.

Recently, modality-specific measures of the strength of perceptual experience (Lynott & Connell 2009, 2013) have proven themselves important predictors of human behaviour in a range of conceptual tasks including word recognition and reading (Connell & Lynott, 2010, 2012, 2014a, 2014b, 2015, 2016). In a megastudy of over 32,000 words from across the abstract-concrete spectrum, we asked people to provide modality-specific ratings of perceptual strength for six modalities: the usual five (auditory, haptic, gustatory, olfactory, visual) plus the new category of interoceptive strength. We found that interoceptive information dominates the perceptual profile of a sizeable number of concepts (9%; e.g., *hangover*, *eternal*, *remorse*), less than the proportion of concepts dominated by vision (74%; e.g., *book*) or sound (12%; e.g., *melody*), but more than are dominated by touch (3%; e.g., *silky*), gustation (2%; e.g., *candy*), or olfaction (<1%; e.g., *bleach*). Using principal components analysis to examine how interoception relates to the other perceptual modalities, we found that it tends to be strongly loaded against visual and haptic strength (i.e., that which is sensed within the body can be neither seen nor touched) but is relatively distinct from sound, taste, and smell.

Finally, we tested whether interoceptive strength offers valuable information to conceptual content by examining its role in semantic facilitation of word recognition. Maximum perceptual strength (i.e., strength in the dominant modality) has previously been shown to predict word recognition performance better than concreteness or imageability (Connell & Lynott, 2012). We therefore compared the predictive ability of two different versions of maximum

perceptual strength: the original measure based on five traditional modalities, and a new version based on six modalities including interoceptive strength. In a regression analysis of lexical decision and word naming performance, interoceptive information considerably improved the efficacy of maximum perceptual strength in predicting both response time and accuracy (Bayes Factors ranged from $BF_{10} = 3.303 \times 10^7$ to $BF_{10} = 3.059 \times 10^{16}$). That is, perceptually strong words were recognized more quickly and accurately than perceptually weak words, and interoceptive strength was a valuable component in this perceptual facilitation. Overall, these findings suggest that interoception has comparable status to other modalities in contributing to the perceptual grounding of concepts.

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