# Mental Imagery and Polysemy Processing

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## Abstract

Recent research in psycholinguistics suggests that language processing frequently involves mental imagery. This paper focuses on visual imagery and discusses two issues regarding the processing of polysemous words (i.e. words with multiple related meanings or senses) – co-predication and sense-relatedness. It aims to show how mental imagery can illuminate these two issues.

## 1. Introduction

On one popular view, language processing is independent from the brain's perceptual and motor systems and aligns with 'the faculty of language in the narrow sense', involving only abstract symbol manipulation, where words in a given sentence are represented by arbitrary symbols which then compose to render the propositional structure of the sentence.[1] Recent work in psycholinguistics adopts a different view of language processing, not only as encompassing 'the faculty of language in the broad sense', but also as frequently involving perceptual-motor simulations.[2] Simulation in this context refers to 'the reenactment of perceptual, motor, and introspective states acquired during experience with the world, body, and mind'.[3] Perceptual simulation, which this paper focuses on, is equivalent to what some psychologists call 'mental imagery', i.e. 'representations of … sensory information without direct external stimulus'.[4] According to the simulation view of language comprehension,.[5]

It is worth noting that the simulation view need not reject the claim that language processing involves abstract symbol manipulation. Nor must it commit to the claim that simulation is necessary or sufficient for all language processing.[6] The key idea is that, in many situations, simulation is part of understanding language – 'we understand language by simulating in our minds what it would be like to experience the things that the language describes'.[7] For instance, there is abundant behavioural evidence that language users activate visual imagery of various features of the objects described in language, including objects' orientations,[8] shapes,[9] spatial relations,[10]

[1] Chomsky 1957; Hauser et al. 2002.

[2] E.g. Barsalou 2008; Zwaan 2003, 2009; Zwaan and Madden 2005; Bergen 2012, 2015.

[3] Barsalou 2008: 618

[4] Pearson et al. 2015

[5] Zwaan and Madden 2005

[6] Dove 2009; Bergen 2012, 2015

[7] Bergen 2012: 13.

[8] Stanfield and Zwaan 2001

[9] Zwaan et al. 2002

[10] Zwaan and Yaxley 2003

motions,[11] and colours.[12] Perceptual simulation is not just a 'downstream effect', but plausibly plays a crucial role in understanding language that describes concrete objects.[13]

Focusing on visual imagery, this paper aims to show how mental imagery can illuminate certain phenomena pertaining to the processing of polysemy, i.e. words with multiple, related meanings or senses. The structure of the paper is as follows. §2 outlines two key issues in relation to polysemy – *co-predication* associated with so-called logical polysemy and *sense-relatedness*, which is often thought to impact polysemy processing. §3 sketches how mental imagery can shed light on the two issues.

## 2. Polysemy

Polysemy is a common linguistic phenomenon where a word has multiple, related meanings or senses. It is distinguished from homonymy, where a word has multiple but unrelated meanings. Theorists distinguish *regular* polysemes, which exhibit systematic patterns, from *irregular* polysemes, which are usually one-offs.[14] Most regular polysemes are based on metonymy, where a word for one thing is used to denote a contiguous or related thing. Metonymic relations include animal for meat (e.g. 'chicken', 'lamb'); container for content (e.g. 'CD', 'bottle'); count for mass (e.g. 'oak', 'pine').[15] Many irregular polysemes are metaphor-based, where the relevant metaphor creatively draws on a similarity between two distinct things in certain respects. The sense of 'expire' that means 'become invalid' is a metaphorical extension of the sense that means 'die', and the relevant similarity is something coming to the end of a period.[16]

### 2.1. Logical Polysemy and Co-predication

A particular subtype of regular polysemy – logical polysemy – has generated much discussion.[17] Unlike many polysemes where the coordination of different senses results in zeugma (e.g. '*John and his student card expired'), logical polysemes typically permit *co-predication*, where a nominal polyseme has multiple predications selecting different senses of the polyseme.[18] Consider:

[11] Zwaan et al. 2004; Liu and Bergen 2016

[12] Richter and Zwaan 2009

[13] Shapiro et al. 2005; Kemmerer 2005; Kaschak et al. 2005; Bergen 2012: ch.10. Empirical evidence also shows that motor simulation has a functional role to play in processing language that describes actions (see Shapiro et al. 2001, 2005; Glenberg and Kaschak 2002; Richardson et al. 2003; Bergen et al. 2007; Bergen 2012).

[14] Apresjan 1974; Falkum and Vicente 2015; Vicente 2018; Carston 2020

[15] Apresjan 1974; Falkum & Vicente 2015; Klepousniotou and Baum 2007

[16] The distinction between metonymy-based and metaphor-based polysemy should not be confused with the distinction between regular and irregular polysemy. Many metaphor-based polysemes are systematic or regular, e.g. words for body parts denoting corresponding parts of inanimate objects ('mouth of the river'); whereas some metonymy-based polysemes are one-off and irregular, e.g. 'Linda is a pretty *face*'.

[17] Asher 2011; Falkum and Vicente 2015; Pustejovsky 1995; Ortega and Vicente 2019

[18] Two points are worth noting. First, while a logical polyseme permits co-predication in some of its occurrences, it does not always permit co-predication. See sentence (2) below. Second, while co-predication is here defined with respect to polysemous nouns, it can also occur with polysemous verbs, e.g. 'John writes movingly but legibly' (Vicente 2021a, 2021b). In discussing co-predication, I shall focus on polysemous nouns.

(1) a. The book is covered with dust but still insightful.
b. Lunch was delicious but took a long time.

'Book' denotes either *tome* or *content*, whereas 'lunch' denotes either *food* or *event*. Other examples of logical polysemes include words for organisations, e.g. 'school', which can refer to an institution (e.g. 'a drama school'), a physical building (e.g. 'The school caught fire'), or a group of people (e.g. 'The school visited the museum'), and place names, e.g. 'London', which can refer to a geographical location, a population, or a political-economic entity. Logical polysemes are often thought to pose a problem for the idea that word meaning is a denotation stable across contexts.[19]

Various explanations have been proposed to account for why logical polysemes permit co-predication. On an ontological explanation proposed by Gotham, a logical polyseme in a co-predicational sentence has a single unitary denotation, which is a mereological composite with different parts, e.g. a book has a tome-part and a content-part.[20] Such an account is nevertheless problematic. Consider the persistence conditions for mereological composites. On the one hand, it seems that the object as whole can survive while some of the parts are destroyed. London can survive in the event that London-as-population is destroyed. On the other hand, the parts can also persist independently from each other. London-as-population may be moved to a new location while London-as-place remains in the same location. This would mean that London can potentially persist in several different entities. But the account precisely entails that London is a single mereological composite.[21]

Ortega-Andrés and Vicente propose a psychological explanation, on which different senses of a logical polyseme form an 'activation package' such that the activation of one sense does not inhibit other senses.[22] This account also faces problems. First, it is unclear why different senses of a logical polyseme form an 'activation package'.[23] Second, the account faces counterexamples.[24] Consider:

(2) *The school caught fire when visiting the museum.

(2), though it contains the logical polyseme 'school', is zeugmatic. However, Ortega-Andrés and Vicente's proposal fails to predict the oddness. In the first conjunct, the sense of 'school' selected refers to a building, whereas the sense selected in the second conjunct refers to a group of people. Since the activation of one sense should not suppress the activation of another sense, their account wrongly predicts that (2) does not sound odd. So, the phenomenon of co-predication remains to be clarified.

### 2.2. Polysemy Processing and Sense-Relatedness

Recent research in psycholinguistics has also shown differences in processing between polysemy and homonymy, as well as between different kinds of polysemy, i.e. metonymy-based versus

[19] Chomsky 2000; Collins 2009; Vicente 2021a, 2021b

[20] Gotham 2017. For other ontological proposals, see Asher 2011; Arapinis and Vieu 2015; Liebesman and Magidor 2017. For critiques of these accounts, see Collins 2017; Vicente 2021a, 2021b.

[21] See Vicente 2021a: 926

[22] Ortega-Andrés and Vicente 2019. While ontological explanations mentioned in fn20 all take the logical polyseme in a co-predicational sentence to have one denotation, e.g. a mereological composite, this psychological explanation takes it to have multiple denotations, e.g. book-as-tome and book-as-content.

[23] Ortega-Andrés and Vicente (2019) contend that that denotations of different senses of a logical polyseme mostly stand in realization relations, e.g. the content of a book is realized in a tome (see also Vicente 2021a). But this still leaves the question of why senses standing in realization relations form an 'activation package'.

[24] See also Vicente 2019

metaphor-based.[25] With respect to homonymy, it is generally agreed that different meanings of a homonym (e.g. 'bat') are represented separately in the mental lexicon, and language users make an immediate semantic commitment to a specific meaning. In neutral contexts the dominant or more frequently-used meaning of a homonym is accessed, but contexts supporting a subordinate meaning can make the relevant subordinate meaning more accessible.[26] In contrast, different senses of a polyseme are often thought to share a single representation and language users do not immediately commit to a specific sense in neutral contexts.[27] Eye-tracking experiments have shown that polysemous words occurring before disambiguating information are processed as fast as unambiguous control words which have single lexical entries, whereas homonyms take longer to process.[28] Against the one-representation view, Klein and Murphy provided evidence that polysemes, like homonyms, have separate representations for each sense.[29] However, the disagreement here is likely due to the type of polysemy used[30] – Klein and Murphy themselves acknowledge that they 'chose senses of words that were fairly distinct'.[31] A number of studies by Klepousniotou and colleagues have provided evidence that the degree of sense-relatedness is what drives polysemy processing – metonymic, including logical, polysemes, where the senses are closely related, are processed more easily than metaphoric polysemes, where the senses are less closely related.[32] Overall, it seems that different types of polysemy are differently represented depending on how closely related the senses are.

However, it is unclear how the notion of sense-relatedness is supposed to be understood,[33] such that the different senses of a logical polyseme or a metonymic polyseme are intuitively judged to be more related or similar compared to the senses of a metaphoric polyseme.[34] Klepousniotou et al. suggest that the different senses of a polysemous word share a core representation, i.e. 'a memory structure encompassing all semantic features that are common across multiple senses of a polysemous word'.[35] On such a view, different senses of a logical polyseme or a metonymic

[25] See Frazier and Rayner 1990; Frisson and Pickering 1999; Klepousniotou 2002; Klepousniotou and Baum 2007; Klepousniotou et al. 2008, 2012; Bocher et al. 2016

[26] Frazier and Rayner 1990; Frisson and Pickering 1999

[27] There are different versions of this one-representation view. According to the underspecification view, the representation of the meaning of a polysemous word is semantically thin – different senses of a polyseme are not stored or encoded but only determined in context (Frisson 2009). The problem with this view is that it is unclear what exactly is included in this thin representation. According to the overspecification view, the representation of the meaning of a polysemous word contains rich information – all senses of a polyseme are stored and language users typically select the specific sense in context (Carston 2019, 2020). This view might seem uneconomical or inefficient as many polysemes can have a large number of senses (Frisson and Pickering 2001; Frisson 2009:115). According to the literalist view, the representation of the meaning of a polysemous word only captures the literal meaning – probably the dominant sense of the word – and other senses may be derived through lexical rules, e.g. animal-for-meat, container-for-content (Copestake and Briscoe 1992). But it is not always clear what the literal sense of a polyseme is. A rule-based account also has a limited reach as different senses of a polyseme may be related in a wide range of ways (Lehrer 1990; Falkum 2015).

[28] Frazier and Rayner 1990; Pickering and Frisson 2001

[29] Klein and Murphy 2001, 2002. See Foraker and Murphy (2002) for evidence that certain polysemes, like homonyms, show dominance effects where language users access the dominant sense of the word in neutral contexts.

[30] Klepousniotou et al. 2008; Bocher et al. 2016

[31] Klein and Murphy 2001: 278

[32] Klepousniotou and Baum 2007; Klepousniotou et al. 2008; see also Frazier and Rayner 1990; Bocher et al. 2016

[33] See Carston 2020: 113-114

[34] Klepousniotou et al. 2008: Appendices B&C; Bocher et al. 2016

[35] Klepousniotou et al. 2008: 1535

polyseme share more common features compared to different senses of a metaphoric polyseme. However, this proposal is puzzling because different senses of a logical polyseme or a metonymic polyseme do not seem to share many common features.[36] While a chicken-as-animal may be cute, feathery and chirpy, chicken-as-meat certainly is not. Similarly, it is unclear what common features book-as-tome and book-as-content share – one is a concrete physical entity and the other an abstract entity that can have different physical realizations – despite the fact that the two senses seem closely related. So, the notion of sense-relatedness also remains to be clarified.

## 3. Explanatory Power of Mental Imagery

In the last section, I outlined two key issues in relation to polysemy – *co-predication* with respect to logical polysemes, and *sense-relatedness*, which plausibly drives polysemy processing. This section explains these two phenomena using the simulation view of language processing. The goal here is modest. It is not to argue for the best accounts of co-predication and sense-relatedness, but to sketch how mental imagery can make sense of these two phenomena.

On the simulation view, comprehending a sentence or clause describing things with visual features often involves constructing mental imagery of a *focal entity* (usually indicated by the subject of a clause).[37] The content of such mental imagery resembles the content of actual perceptual experiences where the relevant stimulus is present, and is determined by various factors, including contextual information and encyclopaedic knowledge.[38] For instance, the mental imagery associated with the sentence 'A red ball is on the table' has the focal entity of a ball. What the image looks like depends on what else is mentioned by the sentence, e.g. it is 'red' and 'on the table', and one's encyclopaedic knowledge about the focal entity, e.g. the shape of a ball.

Now recall that co-predication involves multiple predicates simultaneously selecting different senses of a nominal polyseme. Consider (1a) again:

(1) a. The book is covered with dust but still insightful.

(1a) contains two conjuncts corresponding to two predicates. Let's consider each conjunct separately:

(1) a.i. The book is covered with dust. (book-as-tome)
a.ii. The book is insightful. (book-as-content)

Denotations of different senses of a logical polyseme often stand in realization relations.[39] Book-as-content is realized in a book-as-tome. Given our experiences of the realized are usually experiences of the realizers, our experiences of book-as-content are usually experiences of a book-as-tome. As a result, our mental imagery of a book-as-content plausibly overlaps significantly with the mental imagery of book-as-tome. This suggests that processing (1a.i) and (1a.ii) often involves constructing two mental images with the same focal entity, i.e. a book-as-tome. Note that talking in terms of mental imagery avoids problems associated with talking in terms of referents. While book-as-tome does not seem to have much commonality with book-as-content, the mental images of the two are certainly similar or identical.

Turning to the processing of (1a). On a simulation view, meaning construction is a dynamic and active process where language users simulate as they encounter different elements in

[36] Foraker and Murphy 2012: 424; Carston 2020: 113; Hogeweg and Vicente 2020: 878

[37] See Zwaan and Madden 2005. While the focal entity in an active construction (e.g. 'Tom threw the ball') is usually the entity that performs the action (e.g. 'Tom'), in a passive construction (e.g. 'The ball was thrown by Tom'), the focal entity is usually the entity that undergoes an action (e.g. 'ball').

[38] Zwaan and Madden 2005

[39] Vicente 2021a

a sentence.[40] In processing (1a), the phrase 'the book' first activates mental imagery of a typical book-as-tome. In processing the first conjunct, the language user homes in on the specific aspect of the imagery of a book, i.e. its surface feature. In processing the second conjunct, she continues to think of the same focal entity and think of it as being insightful.[41] Overall, the whole sentence generates mental imagery of a visual scene with a book as the focal entity.

I contend that in co-predicational sentences involving different senses of a nominal polyseme, conflicting mental imagery generates zeugma. For two mental images to be conflicting, they would have to involve different focal entities, e.g. a mental image of a bat-as-equipment and that of a bat-as-animal. On this account, if the conjuncts occurring later in a co-predicational sentence require language users to construct mental imagery conflicting with that required by those occurring earlier, then co-predication is not allowed; if this is not required, then co-predication is permitted. In (1a), the mental imagery associated with the first conjunct contains a visual representation of a book-as-tome. Since the second conjunct does not require language users to construct mental imagery with a different focal entity, (1a) is felicitous.

In contrast, consider (3):

(3) *The chicken was delicious and chirpy.

The mental imagery of chicken-as-meat associated with the first conjunct conflicts with that of a chicken-as-animal associated with the second conjunct, and the sentence is zeugmatic. Consider also (2) from §2:

(2) *The school caught fire when visiting the museum.

The first conjunct activates mental imagery of a building. The second conjunct, however, requires the language user to construct mental imagery with a different focal entity, i.e. a group of people. As the current account predicts, (2) is zeugmatic. However, consider (4):

(4) The school caught fire when celebrating the principal's retirement.

(2) and (4) are similar – they have the same first conjunct and the sense of 'school' in both second conjuncts refers to a group of people. (4) nevertheless seems permissible. How then should we explain the permissibility of (4)?

(4) plausibly does not involve conflicting mental imagery. Bergen suggests that language processing, on a simulation view, can be thought of as a two-staged process.[42] The first stage involves incremental simulation where the language user builds up pieces of the sentence as they process different parts of the sentence. The second stage involves wrap-up simulation where the language user may return to key parts of the incremental simulation and re-construct appropriate mental imagery. In the case of (4), it seems plausible that in reaching the end of the second conjunct, the language user can quickly update the mental imagery and resolve the conflicting mental imagery generated during incremental simulation. In processing (4), the word 'school' first activates initial mental imagery of a typical school – mental imagery of a building plus people. The first predicate 'caught fire' homes in on a specific part of the imagery, i.e. the building part. The second conjunct then brings other aspects of the initial imagery (e.g. people associated with school) into focus. This initial conflict in focal entities is nevertheless resolved during wrap-up simulation where the language user is prompted to construct mental imagery with a single (though complex) focal

[40] Bergen 2015

[41] Processing the predicate 'insightful' might or might not involve simulation. The point here is that there is no need for a change in focal entity for the second conjunct because our typical experience of a book-as-content is an experience of a book-as-tome.

[42] See Bergen 2012: 139

entity – part of this focal entity (i.e. the building-part) 'caught fire' and part of it (i.e. the people-part) is 'celebrating'. In contrast, (2) describes two simultaneous events at different locations and involves conflicting mental imagery that cannot be resolved.[43]

While more may need to be said,[44] the above discussion outlines how the hypothesis that language processing involves mental imagery can shed light on co-predication. Logical polysemes can permit co-predication because language users need not construct conflicting mental imagery in relation to different predicates. This explanation of co-predication complements and elaborates on Ortega-Andrés and Vicente's psychological account, on which different senses of a logical polyseme form an 'activation package' such that the activation of one sense, at least in some cases, does not inhibit that of others.[45] This occurs, according to the current account, when language users can automatically construct mental imagery with a single (perhaps composite) focal entity.

Mental imagery can also illuminate the notion of sense-relatedness. Judgements of sense-relatedness are usually elicited upon reading phrases or sentences containing polysemous nouns which allow readers to home in on the specific senses.[46] Different features of mental imagery can help explain people's judgements, which may depend on similarities in mental imagery associated with different senses. If so, then it is no surprise that the different senses of a logical polyseme, where corresponding mental images are most likely similar, would usually be judged to be more related or similar than those of a metaphoric polyseme, e.g. 'mouth', where the mental images of the different senses are very different (compare the mental imagery of a mouth on the lower part of a face with that of a mouth of a river). Indeed, in Klepousniotou et al.'s study, logical polysemes like 'article', 'book', 'dinner', etc. received the highest ratings for semantic relatedness.[47]

In addition to appealing to similarities in mental imagery, judgements of how closely related two senses of a polyseme are may be influenced by the interconnectedness of mental imagery associated with the different senses. The activation of mental imagery of a fried egg supports that of a frying pan rather than that of an egg carton. The mental imagery of chicken-as-meat is likely to activate that of a chicken-as-animal. Such interconnectedness is primarily established through co-occurrences of the referents,[48] e.g. fried eggs co-occur with frying pans whereas uncooked eggs co-occur with cartons, or their dependency relations, e.g. chicken-as-meat depends on chicken-as-animal. It is thus no surprise that metonymic polysemes, based on lexical extension through using a word for one thing to denote an often co-occurrent (e.g. bottle-as-container for bottle-as-liquid) or dependent thing (e.g. chicken-as-animal for chicken-as-meat), are usually judged to have more closely related senses than metaphoric polysemes where different senses denote entities that usually do not co-occur or depend on one another. Explaining sense-relatedness in terms of mental imagery also captures individual differences in judgements, since

[43] It is worth noting that there are likely to be individual differences with respect to our judgements about whether certain co-predicational sentences are odd. Such differences can easily be accommodated by the current account, since individual differences in judgements of sentence oddness may track corresponding differences in the construction of mental imagery. For instance, someone who does not resolve the conflicting mental imagery in the wrap-up simulation stage would nevertheless find (4) zeugmatic. It would also be of interest to test whether aphantasia subjects, who either do not have or are not aware of mental imagery, judge sentences like (2)-(4) as odd.

[44] There is a question as to whether this explanation of co-predication commits to the view that mental imagery is necessary for processing co-predicational sentences. It need not. Here, one might draw a distinction between simply understanding a sentence on the one hand and judging whether or not a sentence is odd on the other. The latter elicits an explicit judgement about the meaning of a sentence and plausibly demands deeper understanding, in which case it is likely that simulation would be involved.

[45] Ortega-Andrés and Vicente 2019

[46] Klepousniotou et al. 2008; Bocher 2016

[47] Klepousniotou et al. 2008

[48] Zwaan and Madden 2005

how similar or interconnected the relevant mental images are may vary interpersonally due to differences in culture or personal history.

In this paper, I have sketched how mental imagery can illuminate two important issues with respect to polysemy – co-predication and sense-relatedness. Given the explanatory payoff, the discussion here also lends support to the hypothesis that language processing involves mental imagery in the relevant cases (i.e. in assessing whether a co-predicational sentence is odd and considering how closely related the different senses of a polyseme are). While the paper has only focused on the role of mental imagery in polysemy processing, more discussion on mental imagery awaits with respect to other types of linguistic phenomena, e.g. figurative language, and language comprehension in general.

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