Language and Cognition (2024), 1–26
doi:10.1017/langcog.2023.73

ARTICLE

The ambiguous nature of complex semantic types: an experimental investigation

Richard Huyghe[1], Lucie Barque[2], François Delafontaine[1] and Justine Salvadori[1]

[1]University of Fribourg, Fribourg, Switzerland; [2]Université Sorbonne Paris Nord, LLF, CNRS, Paris, France
Corresponding author: Richard Huyghe; Email: richard.huyghe@unifr.ch

(Received 22 July 2023; Revised 18 December 2023; Accepted 19 December 2023)

Abstract
Words with complex semantic types such as *book* are characterised by a multiplicity of interpretations that are not mutually exclusive (e.g., as a physical object and/or informational content). Their status with respect to lexical ambiguity is notoriously unclear, and it is debatable whether complex types are a particular form of polysemy (closely related to metonymy) or whether they belong to monosemy. In this study, we investigate the nature of complex types by conducting two experiments on ambiguous nouns in French. The first experiment collects speakers' judgements about the sameness of meaning between different uses of complex-type, metonymic and monosemous words. The second experiment uses a priming paradigm and a sensicality task to investigate the online processing of complex-type words, as opposed to metonymic and monosemous words. Overall results indicate that, on a continuum of lexical ambiguity, complex types are closer to monosemy than to metonymy. The different interpretations of complex-type words are highly connected and fall under the same meaning, arguably in relation to a unique reference. These results suggest that complex types are associated with single underspecified entries in the mental lexicon. Moreover, they highlight the need for a model of lexical representations of ambiguous words that can account for the difference between complex types and metonymy.

Keywords: complex type; copredication; French; lexical ambiguity; metonymy; monosemy; regular polysemy

1. Introduction

Words with complex semantic types such as *book* are characterised by a multiplicity of interpretations that are not mutually exclusive. *Book* can denote both an informational content and a physical object. It can be used in contexts that describe these two referential aspects, such as (1) where *interesting* applies to the informational content, and *heavy* to the physical object.

(1) This book is very interesting, but it's awfully heavy to carry around. (Cruse, 2004, 74)

Complex types have been extensively discussed in studies on polysemy. However, their exact status with respect to lexical ambiguity remains uncertain, and the semantic structure of complex-type words is still under debate. No consensus has been reached as to whether complex types are a particular form of polysemy (closely related to metonymy) or whether they are more akin to monosemy. While many theoretical linguists have described complex types as polysemous in nature (e.g., Ortega-Andrés & Vicente, 2019; Pustejovsky, 1995), it has also been argued that they should be rather regarded as single gestalts and that they are not ambiguous in the strict sense of the word (e.g., Cruse, 1995; Liebesman & Magidor, 2017). On the other hand, studies in psycholinguistics have explored the cognitive aspects and the different forms of lexical ambiguity, but have rarely examined complex types in contrast with other forms of ambiguity. In most cases, complex types have been investigated jointly with prototypical metonymic words (e.g., Foraker & Murphy, 2012; Klepousniotou et al., 2008). It follows that the representation of complex types in the mental lexicon and the extent to which they may differ cognitively from prototypical polysemous or monosemous words are largely unknown. Moreover, the lack of distinction between complex types and polysemy could affect the conclusions drawn from experimental studies. If complex-type and polysemous words are differently processed and represented in the mind, then they should be carefully separated in the linguistic materials used in psycholinguistic research on ambiguous words.

The purpose of this paper is to investigate empirically the nature of complex types with respect to lexical ambiguity. To improve our understanding of complex types, we conducted two experiments comparing them with both monosemy and polysemy (especially regular metonymy) in French. The first experiment examines native speakers' intuitions and metalinguistic judgements about the sameness of meaning between different uses of complex-type, monosemous and polysemous words. The second experiment uses a priming paradigm and a sensicality task to determine whether speakers' judgements are consistent with representations of the different types of words in the mental lexicon. The main hypothesis tested in these experiments is that complex types are closer to monosemy than to polysemy on a continuum of lexical ambiguity, mostly because of their single reference. Our contribution is twofold since we seek to answer theoretical research questions based on experimental evidence, as well as to provide empirical support for the relevance of fine semantic distinctions in psycholinguistic research. While focusing on the case of complex semantic types, we attempt to bridge the gap between linguistic and psycholinguistic studies on lexical ambiguity.

The article is organised as follows: In Section 2, we present the background of the study and examine how complex types have been addressed in previous research. In Sections 3 and 4, we describe the methodology and results of the first and second experiments, respectively. The outcomes of both experiments are discussed in Section 5.

2. Complex types in question

This section describes the characteristics of complex semantic types, based on the literature on lexical ambiguity. We discuss the linguistic properties of complex types

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

and their representation in the mental lexicon. We then present the motivation and objectives of the current study.

2.1. Linguistic properties of complex types

Words with complex semantic types, also known as dot types (Asher, 2011; Pustejovsky, 1995) or semantic facets (Croft & Cruse, 2004; Cruse, 1995), are associated with multiple senses that are contextually compatible. This property manifests itself through copredication, defined as the application to the same argument of two predicates which are distinctive of different semantic types, with no zeugma effect. In (2a), for example, *burn* is distinctive of the PHYSICAL OBJECT type, and *be translated* is distinctive of the INFORMATIONAL CONTENT type. The two predicates are applied jointly to the noun *book* and the acceptability of the sentence indicates that the two senses of *book* are compatible. Similarly, copredication can be observed for the EVENT and INFORMATIONAL CONTENT senses of *lecture* in (2b), and for the PLACE and INSTITUTION senses of *school* in (2c).

(2) a. That book that you burned was translated into 7 languages. (Duek Silveira Bueno, 2017, 9)
b. The lecture lasted an hour and was very interesting. (Asher, 2011, 99)
c. The school caught fire. It was celebrating 4th of July. (Ortega-Andrés & Vicente, 2019, 2)

Copredication acceptability is known to be affected by several factors, including syntactic construction, predicate order, and pragmatic coherence (Asher, 2011; Duek Silveira Bueno, 2017; Löhr & Michel, 2022; Murphy, 2021a, 2021b). However, only some words with multiple senses pass copredication tests robustly (Jezek & Vieu, 2014; Vicente, 2021), thus contrasting with standard ambiguous words. For example, the sentences in (3) are hardly interpretable, although they parallel those in (2) in terms of copredication structures – with a relative clause in (3a), coordination in (3b), and anaphora binding in (3c). Infelicitous copredications in (3) can be explained by the fact that the two metonymically related senses of *crown*, the two metaphorically related senses of *mouse*, and the two homonymous meanings of *band* are incompatible.

(3) a. #The crown that is made of gold was defeated in the civil war.
b. #This mouse is designed for ambidextrous use and takes refuge in the attic.
c. #She tied her hair with a band. It was playing old rock'n'roll songs.

Sense compatibility for complex-type words can also be observed through contextual underspecification, when a single predicate involves both senses indistinctively (Cruse, 1995, 2004). For example, (4a) describes the giving of both a physical object and an informational content; the change denoted in (4b) involves both places and institutions; and in (4c) Mary simultaneously took part in an event and was provided with some information. Conversely, a predicate cannot apply to incompatible senses of a word without causing ambiguity. For example, *a beautiful mouse* cannot refer simultaneously to the animal and the object.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

(4) a. John gave his sister a book for her birthday.
b. Their daughter changed schools last year.
c. Mary attended the lecture.

Another feature that distinguishes complex types from standard polysemy is the absence of logical ordering of word senses. Polysemy usually involves both a semantic relationship between the different senses of a word and a semantic derivation from one sense to the other, mostly through metaphor or metonymy. Such a derivation seems difficult to establish in the case of complex types. One can hardly tell which is the primary sense between PHYSICAL OBJECT and INFORMATIONAL CONTENT for a noun like *book*, or between EVENT and INFORMATIONAL CONTENT for a noun like *lecture*, which casts doubt on the existence of sense extension in such cases.

In the literature on lexical ambiguity, complex types are generally regarded as a special case of polysemy, sometimes called 'inherent' or 'logical' polysemy (Arapinis & Vieu, 2015; Asher, 2011; Ortega-Andrés & Vicente, 2019; Pustejovsky, 1995; a.o.). The focus being on the systematicity of sense alternations, complex types are often conflated with cases of regular polysemy, defined by the recurring association of specific semantic types in the meaning of ambiguous words (Apresjan, 1974; Copestake & Briscoe, 1995; Dölling, 2020; Falkum & Vicente, 2015; Nunberg, 1995; a.o.). However, considering the characteristics described above, it can be debated whether complex types actually share more features with monosemy than with polysemy. Sense compatibility and possible single reference could distinguish them from polysemy at least as much as sense multiplicity distinguishes them from monosemy. While commenting on the specific properties of complex types as a particular case of regular polysemy, Dölling (2020) notes that 'one might wonder whether applying the term *polysemy* to it is really appropriate.' Cruse (2000) goes so far as to suggest that the different readings of complex-type words 'are not distinct senses, but are distinct conceptual entities within a single sense.' Similarly, Liebesman and Magidor (2017) argue in favour of the univocity of words like *book*, with single meanings submitted to contextual domain restrictions causing their multiple interpretations. One way to advance the debate may be to systematically and empirically confront complex types with the two semantic categories they are potentially close to, that is, regular metonymy on one hand and monosemy on the other.

2.2. Complex types in the mental lexicon

In parallel with theoretical linguistics, lexical ambiguity has attracted a considerable amount of attention in psycholinguistic research. Studies on the psychological aspects of lexical ambiguity have investigated the representation and processing of words with multiple senses or meanings. Different types of ambiguous words have been scrutinized: ambiguous versus unambiguous words (Duffy et al., 1988), homonyms versus polysemes (Brown, 2008; Klein & Murphy, 2001, 2002; Klepousniotou & Baum, 2007; Li & Slevc, 2017; Lukic et al., 2019; MacGregor et al., 2015; Pylkkänen et al., 2006; Rodd et al., 2002), metaphorical versus metonymic words (Klepousniotou et al., 2012, 2008; Lopukhina et al., 2018), regular versus irregular polysemes (Brocher et al., 2016, 2018; Lombard et al., 2021; Maciejewski, 2018; Rabagliati & Snedeker, 2013), and regular polysemes with various degrees of regularity (Lombard et al., 2023). The role of factors such as semantic similarity, relatedness, frequency, and sense dominance has been

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

examined to determine whether the different types of ambiguity are associated with underspecified, core meanings or with multiple entries in the mental lexicon (see Eddington & Tokowicz, 2015 for an overview). Furthermore, human judgements of semantic similarity have been collected for different types of ambiguous words, to be compared with similarity ratings from computational models (Haber & Poesio, 2021; Trott, 2022; Trott & Bergen, 2021).

Taken together, these studies suggest that there is a continuum of ambiguity types, structured by the degree of semantic relatedness and overlap in lexical representations. It is commonly accepted that the different meanings of homonyms are stored separately in the mental lexicon. Researchers have also found that polysemy is advantaged over homonymy in lexical decision tasks and have inferred that polysemous words are associated with more integrated semantic representations than homonyms (Beretta et al., 2005; Rodd et al., 2012, 2002). In addition, heterogeneity can be observed among polysemous words and different degrees of representational overlap can be postulated, with metaphor having an intermediate status between homonymy and metonymy (Klepousniotou, 2002; Klepousniotou et al., 2012; Lopukhina et al., 2018; Yurchenko et al., 2020). A continuum of ambiguity can therefore be drawn from homonymy to monosemy, as represented in Figure 1. The nature of such a continuum is complex and further investigation is needed to clarify the structuring role of semantic relatedness, similarity, and sense association regularity. Nonetheless, we can wonder which exact position complex types would occupy on the continuum, especially with respect to metonymy and monosemy.

Regrettably, complex types have been overlooked in psycholinguistic research on lexical ambiguity, as they have rarely been distinguished from regular polysemy or investigated as a specific type of ambiguity. Complex types have either been conflated with metonymy in varying proportions and contrasted with other forms of lexical ambiguity, or taken as representative of polysemy in general and examined without any contrast with other types of ambiguity. In this context, two studies are of particular interest for the exploration of complex types. First, Frazier and Rayner (1990) have compared in a reading task 'words with multiple senses' (assumed to have a single representation and almost exclusively instantiated by complex-type words) with 'words with multiple meanings' (assumed to have separate representations and exclusively instantiated by homonyms). Their results show that words with multiple senses are processed faster than homonyms and as rapidly as unambiguous words. Second, Frisson (2015) has examined how different models of lexical representation can account for the processing of '*book* polysemies'. The study was based on 24 *book*-type nouns (*dictionary*, *letter*, *report*, etc.) that are all unbalanced in terms of sense dominance: Their interpretation as INFORMATIONAL CONTENT is more frequent than their interpretation as PHYSICAL OBJECT according to corpus annotation. Experimental results indicate that switching from one sense to the other may be

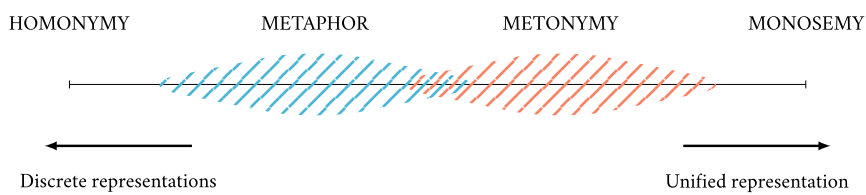

Figure 1. Continuum of lexical ambiguity.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

costly, but that sense dominance has no effect on the lexical processing of the nouns. These results are consistent with an underspecification model in which the INFORMATIONAL CONTENT and PHYSICAL OBJECT senses are not a priori differentiated; but they are not compatible with a separate representation model, which would predict subordinate senses to be more difficult to process than dominant ones.

To the best of our knowledge, there is no study that focuses on complex types and examines their properties in contrast with polysemy. Yet one may ask whether complex-type words are represented and processed differently from polysemous words. In particular, complex-type words may be associated with more integrated or unified representations than standard polysemes, and they may be more similar to monosemous than to polysemous words.

2.3. The present study

In the present study, we combine theoretical and empirical perspectives on lexical ambiguity to investigate the specific nature of complex types. We intend to compare complex types with prototypical monosemy (i.e., single types) on the one hand, and with the form of polysemy that is the most closely related to complex types (i.e., regular metonymy) on the other hand. Our general hypothesis is that complex types pattern with monosemy rather than polysemy in their semantic representation. Admittedly, complex-type words differ from monosemous words in having multiple interpretations that relate to different semantic classes, possibly involved in different hyponymy hierarchies. However, we can think that the non-exclusiveness of senses and potential uniqueness of reference make complex types more similar to monosemy than to polysemy. The possibility of conceiving complex-type words as denoting unique (hybrid) entities makes them more akin to monosemous than to polysemous words in terms of semantic integration. Accordingly, on the ambiguity continuum ranging from complete disjunction to strict identity of meaning, complex types would be closer to single types than to regular metonymy.

To test this hypothesis, we designed two experiments on French that echo previous studies on polysemy, especially those of Brocher et al. (2018), Foraker and Murphy (2012), Haber and Poesio (2021), and Lopukhina et al. (2018) for the first experiment; and Frisson (2015), Klein and Murphy (2001), and Klepousniotou et al. (2008) for the second experiment. The originality of our approach is to systematically distinguish complex types from metonymy and to use monosemy as a baseline for evaluating the semantic properties of complex types. In Experiment 1, we collected speakers' judgements on the sameness of meaning of complex-type words in various sentences, as opposed to monosemous and metonymic words. The task assigned to participants involved conscious evaluation of meaning based on contextual interpretation and lexical knowledge. We examined whether complex-type words are assessed as having greater or lesser differences in meaning than metonymic and monosemous words in different uses. The aim of Experiment 2 was to determine whether the results from the first experiment were supported by online processing of the different types of words. We used a sensicality task to test adjective-noun phrases that select different senses and examined accuracy and response time for different types of nouns. This allowed us to investigate the mental representation of complex types and to determine whether it differs from that of regular metonymic or monosemous words. Assuming that mental representations correlate with linguistic structures, such an investigation

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

can shed light on the lexical status of complex types and provide us with empirical evidence on the structural similarity between complex types, monosemy, and polysemy.

3. Experiment 1: sameness judgements

The first experiment investigated speakers' intuitions and metalinguistic judgements about the meaning of complex-type words, in contrast with metonymic and monosemous words. Participants were asked to rate the sameness of meaning for one word used in two sentences with different interpretations (for metonymy and complex types) and with the same interpretation (for monosemy). We hypothesised that complex types would receive higher ratings than metonymy and lower ratings than monosemy, but that the difference in sameness scores would be significantly greater between complex-type and metonymic words than between complex-type and monosemous words. The method and results of this experiment are detailed in this section.[1]

3.1. Method

3.1.1. Participants

A total of 106 French native speakers aged 19 to 73 ($M = 34$, $SD = 12$) took part in the experiment, with various educational levels from baccalaureate degree to PhD. They were recruited through the Prolific crowdsourcing platform and were financially compensated for their participation.

3.1.2. Materials

The linguistic materials used in the experiment were based on 96 target nouns evenly distributed across three categories: (i) metonymic nouns that fit into a regular polysemy pattern, (ii) complex-type nouns that fit into a type association pattern, and (iii) monosemous nouns that have only one semantic type. Eight patterns of sense alternation were selected, including 4 for metonymy and 4 for complex types, as listed in Table 1. Patterns selected for complex types are those that successfully pass a battery of copredication tests, whereas patterns selected for metonymy involve word senses that are incompatible in most copredication constructions. Copredication was tested in three syntactic structures: with a relative clause, in coordination, and with anaphora, as exemplified in (2)–(3). Each structure was tested with predicates in the two possible orders, to ensure copredicability independently of sense dominance and pragmatic facilitation effects. For example, ACTION/CONTENT was selected as a complex-type pattern based on the possibility to use words with both senses (e.g., *discussion* 'discussion') in the three copredication structures (e.g., coordination in (5)). Conversely, ACTION/AGENT was selected as a metonymic pattern based on the impossibility to use words with both senses (e.g., *rédaction* 'writing'/'editorial staff') in the three copredication structures (e.g., coordination in (6)). Sense alternation patterns whose status as complex or metonymic can be debated (e.g., CONTAINER/

[1]The hypotheses, design plan and materials of Experiment 1 were preregistered prior to data collection and are available at https://osf.io/jv6bn/.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Table 1. Semantic characteristics of lexical material

Ambiguity	Pattern	Ontology	Dominance	Examples
Metonymy	Action/Agent	Eventuality/ Entity	Balanced	*patrouille* 'patrol'
			Biased	*rédaction* 'writing'/'editorial staff'
	Action/Result		Balanced	*collage* 'gluing'/'collage'
			Biased	*préparation* 'preparation'
	Animal/Meat	Entity/Entity	Balanced	*bœuf* 'bullock'/'beef'
			Biased	*poulet* 'chicken'
	Substance/ Artefact		Balanced	*carton* 'cardboard'/'cardboard box'
			Biased	*plâtre* 'plaster'/'cast'
Complex	Action/Content	Eventuality/ Entity	Balanced	*discussion* 'discussion'
			Biased	*discours* 'speech'
	Action/Finance		Balanced	*emprunt* 'loan'
			Biased	*cotisation* 'contribution'
	Artefact/Content	Entity/Entity	Balanced	*tract* 'leaflet'
			Biased	*livre* 'book'
	Place/Institution		Balanced	*hôpital* 'hospital'
			Biased	*banque* 'bank'
Monosemy	NA	Eventuality	NA	*fusillade* 'shooting'
	NA	Entity	NA	*moustache* 'moustache'

CONTAINED, see Duek Silveira Bueno, 2017, contra Partee & Borschev, 2012) were not used in the study.

(5) a. La discussion était très intéressante, mais a été interrompue.
'The discussion was very interesting, but was interrupted'
b. La discussion a été interrompue, mais était très intéressante.
'The discussion was interrupted, but was very interesting'

(6) a. #La rédaction était très en colère et a été reportée.
'The {writing/editorial staff} was very angry and was postponed'
b. #La rédaction a été reportée et était très en colère.
'The {writing/editorial staff} was postponed and was very angry'

To control for the effect of ontological alternation in both metonymic and complex-type patterns, half of the patterns selected for each ambiguity type involved a relationship between an EVENTUALITY and an ENTITY sense, and the other half a relationship between two ENTITY senses. Each pattern was instantiated by 8 nouns evenly distributed between balanced and biased sense dominance, that is, with equally frequent senses or with a dominant and a subordinate sense. Dominance information was obtained from the annotation of random samples of 100 relevant corpus tokens per noun, with control over inter-annotator agreement. Corpus tokens were randomly extracted from FRCOW16A, a French web corpus that contains 10.8 billion tokens (Schäfer, 2015; Schäfer & Bildhauer, 2012). For each token, annotators had to choose between one of the pattern senses, an 'underspecified' label if both senses were contextually selected (in the case of complex-type words), or an 'NA'

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

label if the sentence was ill-formed or uninterpretable. Two nouns per pattern (i.e., a total of 16 nouns) were annotated in a double blind process. Inter-annotator agreement was substantial and slightly higher for metonymic patterns (observed agreement = .86; Cohen's κ = .77) than for complex patterns (observed agreement = .76; Cohen's κ = .65). Biased versus balanced sense dominance was determined by chi-square goodness-of-fit tests. Words were considered biased only if their different senses were significantly unbalanced in frequency in the sample annotated (at $p < .05$).

Target nouns were included in pairs of sentences selecting alternative senses for metonymic and complex-type nouns, and identical senses for monosemous nouns. Pairs of sentences were formed so that each noun was used in the same syntactic position, with the same determiner and same preposition (in PPs) in both sentences. Half of the nouns were used in subject position and the other half in object/oblique position, with an even distribution of subjects and objects/obliques across ambiguity types. Examples of pairs of sentences are given in (7)–(9).

(7) Metonymy (SUBSTANCE/ARTEFACT)
   a. Ce tapis est fait d'un **feutre** synthétique.
      'This rug is made from synthetic felt'
   b. Elle se sert toujours d'un **feutre** effaçable.
      'She always uses an erasable felt-tip pen'

(8) Complex types (ARTEFACT/CONTENT)
   a. Le **certificat** est perforé dans le coin supérieur gauche.
      'The certificate is perforated in the top left corner'
   b. Le **certificat** peut être déclaré invalide.
      'The certificate may be declared invalid'

(9) Monosemy
   a. Ils admirent un **platane** géant au milieu de la place.
      'They admire a giant plane tree in the middle of the square'
   b. La commune a dû abattre un **platane** centenaire.
      'The local authority had to cut down a hundred-year-old plane tree'

Note that target nouns co-occur in stimuli sentences with disambiguating adjectives intended to be re-used in Experiment 2. For example, the adjective *synthétique* 'synthetic' in (7) selects the SUBSTANCE sense of *feutre*, while *effaçable* 'erasable' selects the ARTEFACT sense. Similarly, *perforé* 'perforated' in (8) selects the ARTEFACT sense of *certificat* 'certificate', while *invalide* 'invalide' selects the INFORMATIONAL CONTENT sense. Word length in letters was matched across ambiguity types for both target nouns (metonymy: M = 7.8, SD = 2.7; complex types: M = 7.9, SD = 2.0; monosemy: M = 7.7, SD = 2.1) and adjectives (metonymy: M = 7.7, SD = 1.6; complex types: M = 7.9, SD = 1.5; monosemy: M = 7.6, SD = 1.7).

3.1.3. Procedure

Participants completed an online questionnaire in which they were presented with pairs of stimuli sentences. They were asked to evaluate the extent to which the meaning of target nouns was the same in each pair of sentences. A scale of sameness was proposed, ranging from 0 for completely different meanings to 10 for the exact

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

same meaning. The use of a scale was motivated by possible gradedness in semantic identity judgements (Erk et al., 2009; McCarthy et al., 2016; Trott & Bergen, 2023). The possibility was left open indicating that the target word was unknown.[2]

Participants were evenly split into two groups. Each group was asked to evaluate 52 nouns, comprised of 48 target nouns (16 per ambiguity type) and 4 homonyms used to control attention. The order of the nouns and of the sentences for each noun was randomised. Participants were trained with 4 pairs of sentences (including 2 metonymic, 1 complex-type, and 1 monosemous noun) before performing the test. The experiment lasted 13.6 min on average (*SD* = 9.3).

3.1.4. Data analysis

All responses from a participant were considered invalid and excluded from the analysis if the participant's aggregate rating for the 4 homonymous control words was greater than 12, or if 20% or more of the target words were declared unknown. Data from 5 participants were thus removed. For the remaining 101 participants, we excluded responses for unknown words (25 items, i.e., 0.5% of the data), as well as outlier responses with sameness scores deviating 2.5 SD from the mean, considering that they might be due to lack of attention or handling errors (152 items, i.e., 3.1% of the data). A total of 4,671 responses were finally included in the statistical analysis.

To test our hypotheses, we fitted a linear mixed-effects regression model using the 'lme4' package (Bates et al., 2014) in R (R Core Team, 2022), with sameness scores as the response variable and ambiguity type (i.e., metonymy, complex types or monosemy) as the predictor. As random effects, we only included intercepts for participants and items because models with random slopes did not converge. The normality and homoscedasticity of the residuals were checked graphically. The significance of the fixed effect was assessed through a Wald χ^2 test, using the 'car' package (Fox & Weisberg, 2019), and post hoc pairwise comparisons between levels of the predictor were performed using the 'multcomp' package (Hothorn et al., 2017). We evaluated the predictive performance of the model through conditional and marginal R-squared values computed with the 'MuMin' package (Johnson, 2014; Nakagawa & Schielzeth, 2013). Finally, exploratory analyses were conducted through mixed-effects regression analyses on sameness scores, with dominance, ontological alternation, and semantic patterns as predictors, following the same method as in the case of ambiguity type.

[2]Full instructions in French were 'Nous allons vous présenter deux phrases contenant le même mot. Vous devrez évaluer si le mot a un sens identique ou différent dans ces deux phrases, sur une échelle de 0 à 10 (0 – Le mot a des sens complètement différents dans les deux emplois; 10 – Le mot a exactement le même sens dans les deux emplois). Fiez-vous à vos impressions personnelles. Utilisez bien l'ensemble de l'échelle. Ne recourez à aucune aide extérieure (dictionnaire, avis d'ami·es, etc.) pour répondre aux questions. Si vous ignorez le sens d'un mot présenté, cliquez sur le bouton *Mot inconnu*.' English translation is: 'We will present you with two sentences containing the same word. You will have to assess whether the word has the same or a different meaning in these two sentences, on a scale from 0 to 10 (0 - The word has completely different meanings in the two uses; 10 - The word has exactly the same meaning in both uses). Please rely on your personal intuition and make use of the whole scale. Do not solicit any outside help (dictionary, friends' opinion, etc.) to answer the questions. If you do not know the meaning of a word, click on the *Unknown word* button.'

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

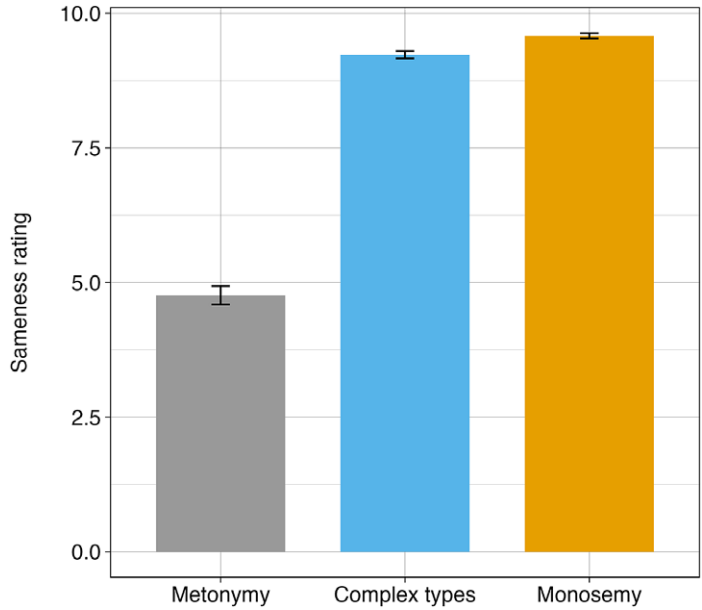

Figure 2. Average sameness scores per ambiguity type with 95% confidence intervals.

3.2. Results

Some variation in judgements of semantic sameness could be observed between ambiguity types, as shown in Figure 2. Average sameness scores were 4.76 for metonymy (*SD* = 3.54), 9.23 for complex types (*SD* = 1.37), and 9.58 for monosemy (*SD* = 0.96). A gap emerged between monosemy and complex types on the one hand and metonymy on the other, not only in mean ratings, but also in dispersion. Sameness judgements showed more variability for metonymy than for complex types and monosemy. This difference was confirmed by the regression analysis. The fitted model showed a significant influence of ambiguity type ($p < .001$). It explained 72% of the variance observed, with ambiguity type explaining 46%. Post hoc pairwise analyses indicated a significant contrast between metonymy and both complex types and monosemy, but not between complex types and monosemy, as reported in Table 2. Our main hypothesis that complex types are closer to monosemy than to metonymy is therefore supported by sameness judgements, to the point that complex-type words can hardly be distinguished from monosemous words. We expected complex-type words to obtain lower sameness scores than monosemous words, but the small difference observed between them was not sufficient to reach significance in inferential analysis.

Table 2. Pairwise comparisons between ambiguity types in the regression model predicting sameness ratings

Contrast	Estimate	*SE*	*z*-value	*p*-value
Metonymy – Complex types	−4.3782	0.3430	−12.763	< .001
Monosemy – Complex types	0.3319	0.3432	0.967	.598
Monosemy – Metonymy	4.7102	0.3430	13.731	< .001

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Table 3. Pairwise comparisons between ambiguity types in the regression model predicting response accuracy

Contrast	Estimate	*SE*	*z*-value	*p*-value
Metonymy – Complex types	−1.1702	0.4116	−2.843	.012
Monosemy – Complex types	0.5290	0.4642	1.140	.489
Monosemy – Metonymy	1.6992	0.4336	3.918	< .001

Further investigations among words with two interpretations (i.e., metonymic and complex-type words), showed no effect of sense dominance or ontological alternation on sameness ratings. Mixed linear regressions[3] revealed that neither dominance nor the interaction between dominance and ambiguity type were significant predictors of sameness ratings (p = .77 and p = .63, respectively). A similar regression analysis indicated that neither ontological alternation nor its interaction with ambiguity type could predict sameness scores (p = .95 and p = .92, respectively).[4]

Only differences in semantic patterns seemed to impact speakers' judgements. A significant effect of patterns on sameness ratings (p < .001) was found in a mixed regression model with random intercepts for items and participants.[5] Interestingly, patterns of regular metonymy appeared to be more heterogeneous than patterns of complex types, as can be seen in Figure 3. Average sameness scores per pattern ranged from 3.02 to 6.53 in the case of regular metonymy, but only from 9.07 to 9.30 in the case of complex types. According to post hoc pairwise comparisons, all patterns of metonymy contrast significantly with all patterns of complex types (p < .05 for each pairwise comparison), and no significant difference can be observed between the 4 patterns of complex types. However, the contrast between certain patterns of metonymy was significant (SUBSTANCE/ARTEFACT vs. ANIMAL/MEAT, p < .001) or marginally significant (ACTION/AGENT vs. ANIMAL/MEAT, p = .081; ACTION/RESULT vs. SUBSTANCE/ARTEFACT, p = .085). These results suggest that there may be a gradient of semantic relatedness among metonymic words that depends on sense alternation patterns, whereas the relationship between the different senses of complex-type words is equally tight across patterns.

4. Experiment 2: semantic priming

The second experiment we conducted was based on semantic priming and aimed to investigate the lexical processing of complex-type words, as opposed to metonymic and monosemous words. We used a sensicality task in which participants were asked

[3]We used the models with the maximal random-effects structure supported by the data. The model with dominance as a fixed effect included by-participant and by-item random intercepts only. The model with the interaction between dominance and ambiguity type additionally included a by-participant random slope for ambiguity type.

[4]The model with ontological alternation as a fixed effect included a by-item random intercept and a by-participant random slope for ontological alternation. The model with the interaction between ontological alternation and ambiguity type additionally included a by-participant random slope for ambiguity type.

[5]The inclusion of a by-participant random slope for patternS was not supported by the data. No combination or interaction between patterns and ambiguity type as fixed effects was tested since sense alternation patterns are fully dependent on metonymy and complex types. The fitted model had a conditional R-squared of .69 and a marginal R-squared of .45.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

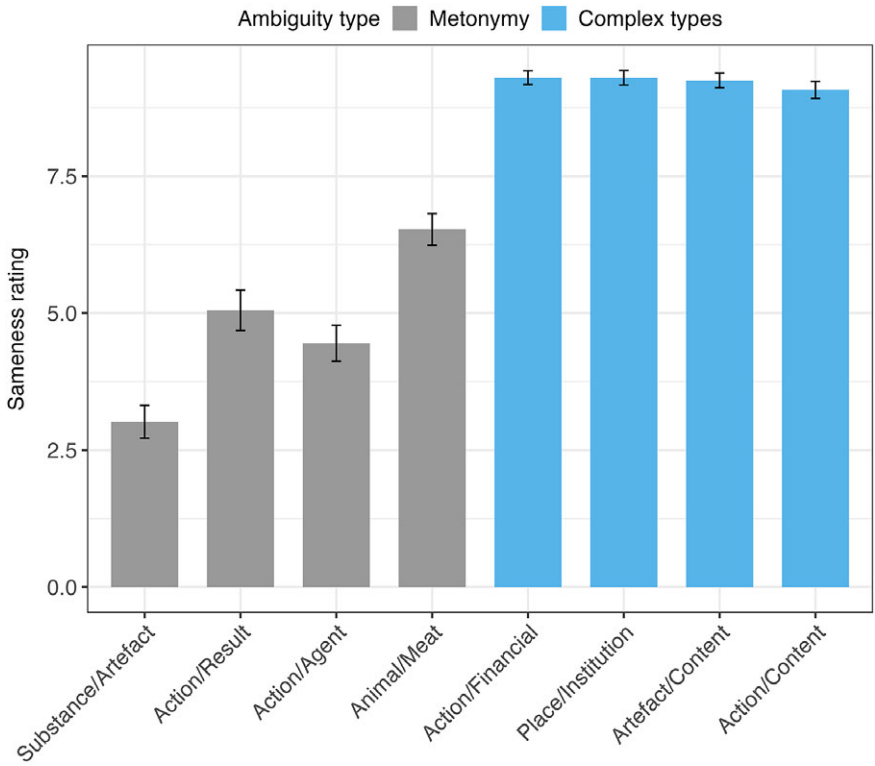

Figure 3. Average sameness scores per semantic pattern with 95% confidence intervals.

to indicate whether adjective-noun phrases made sense or not. Each noun was presented successively with two adjectives, selecting distinct interpretations (for metonymic and complex-type words) or the same interpretation (for monosemous words). We hypothesised that responses would be more accurate and shorter for complex types than for metonymy, and for monosemy than for complex types. We also expected that the difference in accuracy and response time would be significantly greater between complex types and metonymy than between complex types and monosemy. In this section, we present the method and results of this second experiment.[6]

4.1. Method

4.1.1. Participants

A total of 71 French native speakers aged 18 to 34 (M = 24, SD = 4) took part in the experiment. Participants were Bachelor's, Master's, or PhD students recruited at the

[6]The hypotheses, design plan and materials of Experiment 2 were preregistered prior to data collection and are available at https://osf.io/vm9hb/. In the preregistration, we detailed the hypotheses and analysis plan for response times only. In this section, we included the analysis of accuracy and formulated hypotheses that replicate those about response times.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

University of Fribourg and at Université Paris Cité. They were financially compensated for their participation.

4.1.2. Materials

The nouns under scrutiny were the same as in Experiment 1. Each noun was associated with two adjectives already present in the stimuli sentences of Experiment 1 in order to form two adjective-noun phrases that instantiate (i) distinct senses for metonymic and complex-type nouns, (ii) the same sense for monosemous nouns. All adjectives were postposed to the noun they modify. Seventy-two distractor nouns were also included in the materials to form nonsensical phrases. Each distractor noun was associated with two adjectives, one that is consistent with the usual meaning of the noun and one that is not. Examples of adjective-noun phrases for each category are given in (10)–(13).

(10) Metonymy (ACTION/RESULT)
  a. tatouage manuel 'hand tattoing'
  b. tatouage décoloré 'faded tattoo'

(11) Complex types (ACTION/CONTENT)
  a. discours public 'public speech'
  b. discours creux 'empty speech'

(12) Monosemy
  a. décès inattendu 'unexpected death'
  b. décès tragique 'tragic death'

(13) Distractor
  a. massage relaxant 'relaxing massage'
  b. massage pliable 'foldable massage'

Note that our experimental design differs from previous studies using sensicality tasks (Frisson, 2015; Klein & Murphy, 2001; Klepousniotou et al., 2008) in that monosemous nouns were included in the materials. As a consequence, we did not compare conditions in which primes and targets were used in the same sense or in different senses, but contrasted directly ambiguous words (complex-type and metonymic words) with monosemous words.

4.1.3. Procedure

Participants were presented with adjective-noun phrases and asked to assess, as quickly and as accurately as possible, whether each phrase made sense or not. Data was collected using the PsychoPy software (Peirce et al., 2019) installed on a computer in front of which participants were seated. Participants were shown the keyboard keys corresponding to the two possible responses ('O' for sensical phrase, 'E' for non-sensical phrase), and how to position their hands on the keyboard.[7] The experiment took place in the presence of one of the authors of the paper.

[7]Full instructions in French were: 'Vous allez voir apparaître successivement sur l'écran deux paires de mots ayant un mot en commun. Par exemple: *chaise rouge* puis *chaise colérique.* Pour chaque paire, vous devez décider, le plus rapidement possible et sans faire d'erreur, si elle a du sens ou non. Appuyez sur la touche

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Each trial was composed of two adjective-noun phrases including the same noun and different adjectives. After a 200 ms pause, the first phrase appeared on the screen until the participant pressed one of the response keys. Then, after another 200 ms pause, the second phrase appeared on the screen, requiring the participant's answer. At the end of each trial, correct answers were given to the participant, for 2 s if the participant's answers contained an error and for 1 s otherwise. The order of the two phrases appearing on screen was randomised, except for biased nouns, for which phrase order was controlled to alternate between dominant and subordinate senses. The dominant sense was presented as the target (second phrase) for half of the biased nouns and as the prime (first phrase) for the other half. Two nouns per pattern were used in phrases with dominant target.

Participants were split into two groups. Each group was assigned a subsample of the linguistic materials including 48 target nouns (i.e., 96 adjective-noun phrases) and 72 distractor nouns (i.e., 144 adjective-noun phrases). The 48 target nouns were evenly distributed among metonymy, complex types, and monosemy (16 nouns per ambiguity type), and among semantic patterns for metonymy and complex types (4 nouns per pattern). Participants were trained with 8 pairs of phrases before performing the actual test, in which distractors and critical prime-target pairs were presented in random order. The test was completed in 12.8 min on average (SD = 1.1).

4.1.4. Data analysis

Only responses for target phrases were considered in the analysis. We excluded all responses from participants with an error rate greater than 20% on target phrases, which led to the removal of data from 4 participants. All trials with response time (for prime or target) below 200 ms or above 3,000 ms were also excluded (35 items, i.e., 1.1% of the data), as were trials in which participants made an error on the prime (142 items, i.e., 4.4% of the data). The remaining 3,039 data points were used in the analysis of response accuracy. As for response times, they were only analysed for correct responses. All incorrect responses were removed (166 items, i.e., 5.5% of the data considered in accuracy analysis), leaving 2,873 data points to be used in the analysis of response times.

The general principles of statistical analysis were the same as in Experiment 1. We performed a mixed logistic regression to analyse response accuracy and a mixed linear regression to analyse response times, with ambiguity type, noun frequency, and adjective frequency as predictors in both cases. The inclusion of frequencies was motivated by the fact that they were not matched across ambiguity types and by the assumption that greater lexical familiarity might increase accuracy and shorten response times. Word frequencies were taken from the *Lexique* database (New et al., 2004), and frequency variables were scaled and centred on the mean prior to

'O' du clavier si la paire a du sens. Appuyez sur la touche 'E' du clavier si la paire n'a pas de sens. Gardez les index sur ces deux touches tout au long de l'expérience. En cas d'erreur, un message vous indiquera la réponse attendue.' English translation is: 'You will see two pairs of words with one word in common appear on the screen. For example: *chaise rouge* 'red chair' then *chaise colérique* 'angry chair'. For each pair, you have to decide, as quickly as possible and without making any errors, whether the pair makes sense or not. Press the 'O' key on the keyboard if the pair makes sense. Press the 'E' key if the pair does not make sense. Keep your index fingers on both keys throughout the experiment. In the event of an error, a message will indicate the expected answer.'

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

analysis. Random-effects structures were kept maximal as long as they could be supported by the data (Barr et al., 2013; Matuschek et al., 2017). They were simplified if the models did not converge or were singular. Interactions between fixed effects were tested, and the optimal model was selected based on the Akaike information criterion (AIC). Multicollinearity was assessed using the variance inflation factor. Note that response times were log-transformed to meet the assumption of normality of error in the linear regression analysis.

4.2. Results

4.2.1. Accuracy

The accuracy of the responses obtained in the experiment varied according to ambiguity type, as shown in Figure 4. Average accuracy rates were .901 for metonymy (*SD* = .299), .954 for complex types (*SD* = .209), and .978 for monosemy (*SD* = .147). The best regression model to predict response accuracy included ambiguity type and the interaction between noun and adjective frequencies as fixed factors, as well as a by-item random intercept and a by-participant random slope for adjective frequency. The effect on accuracy was significant for ambiguity type ($p < .001$) and marginally significant for the interaction effect ($p = .094$). The model had a conditional R-squared of .58 and a marginal R-squared of .24. Post hoc pairwise analyses revealed a significant contrast between metonymy and both complex types and monosemy, but not between complex types and monosemy (see Table 3). These results are congruent with those of Experiment 1 and confirm that complex types are more similar to monosemy than to metonymy.

Further regression analyses restricted to metonymy and complex types showed no effect on the accuracy of ontological alternation ($p = .249$), nor of its interaction with

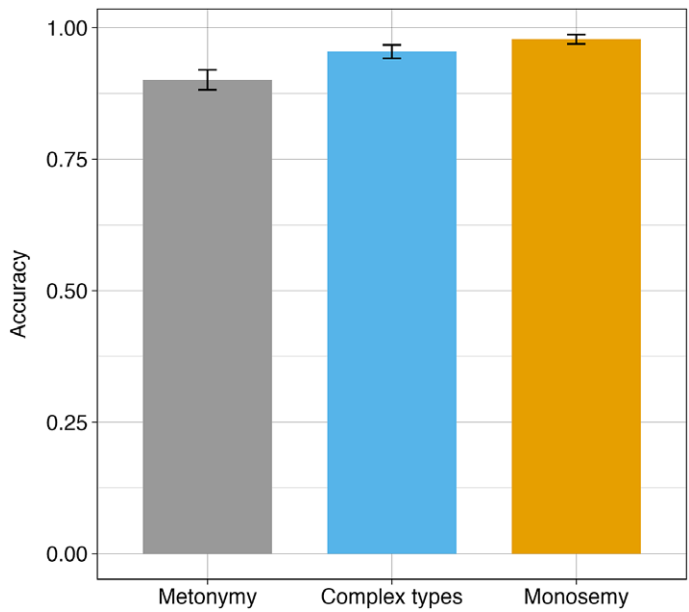

Figure 4. Average response accuracy per ambiguity type with 95% confidence intervals.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

ambiguity type (p = .903). Semantic patterns were found to be a significant predictor of accuracy (p = .030), but when considering pairwise comparisons, only the contrast between the metonymic SUBSTANCE/ARTEFACT pattern and the complex ACTION/CONTENT pattern was significant (p = .008), with higher accuracy for the latter. Therefore, patterns appeared to be less discriminant for response accuracy than for sameness judgements. Finally, sense dominance did not influence response accuracy. Whether the sense used in the target phrase was dominant, subordinate, or balanced did not have a significant effect on accuracy (p = .380), even in interaction with ambiguity type (p = .167).[8]

4.2.2. Response times

Differences in correct response times could be observed between ambiguity types. Average response times were 1,038 ms for metonymic words (SD = 380), 1,018 ms for complex-type words (SD = 362), and 910 ms for monosemous words (SD = 274). The distribution of response times per ambiguity type is represented in Figure 5. The best linear model to fit the data included a by-item random intercept and a by-participant random slope for adjective frequency. It revealed a significant effect of ambiguity type (p < .001) and of the interaction between noun and adjective frequencies (p = .003). Figure 6 illustrates the interaction effect, showing that higher noun frequency increases the effect of adjective frequency on response times. The whole model explained 38% of the variance in response times, and the fixed factors explained 5%. Post hoc pairwise analyses indicated a significant difference between monosemy and both complex types and metonymy, but not between complex types and metonymy (see Table 4). This result contrasts with those obtained for sameness judgements in Experiment 1 and for response accuracy in Experiment 2. It contradicts our expectations, since complex types pattern with metonymy rather than monosemy in correct response times.

Additional regression analyses on metonymic and complex-type words showed no influence of ontological alternation, semantic patterns, or sense dominance on response times. The contrast between nouns with two ENTITY senses and nouns with an ENTITY and an EVENTUALITY sense could not predict correct response times, neither as a single fixed factor (p = .469) nor in interaction with ambiguity type (p = .801). Differences in semantic patterns did not affect response times either (p = .268), nor did the use of a noun with a dominant, subordinate, or balanced sense in the target phrase (p = .817), even in interaction with ambiguity type (p = .591).[9]

[8]The maximal random-effects structures supported by the data were the following: The model with ontological alternation as a fixed effect included by-participant and by-item random intercepts only, and the model with the interaction between ontological alternation and ambiguity type additionally included a by-participant random slope for ambiguity type. The model with patterns as a fixed effect included by-participant and by-item random intercepts only. The model with sense dominance as a fixed effect included by-participant and by-item random intercepts only, and the model with the interaction between sense dominance and ambiguity type additionally included a by-participant random slope for ambiguity type.

[9]The maximal random-effects structures supported by the data were the following: The model with ontological alternation as a fixed effect included a by-item random intercept and a by-participant random slope for ontological alternation. The model with the interaction between ontological alternation and ambiguity type as a fixed effect included a by-item random intercept and a by-participant random slope for the interaction. The model with patterns as a fixed effect included by-participant and by-item random intercepts only. The model with sense dominance as a fixed effect included a by-item random intercept and a by-participant random slope for sense dominance. Finally, the model with the interaction between sense

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

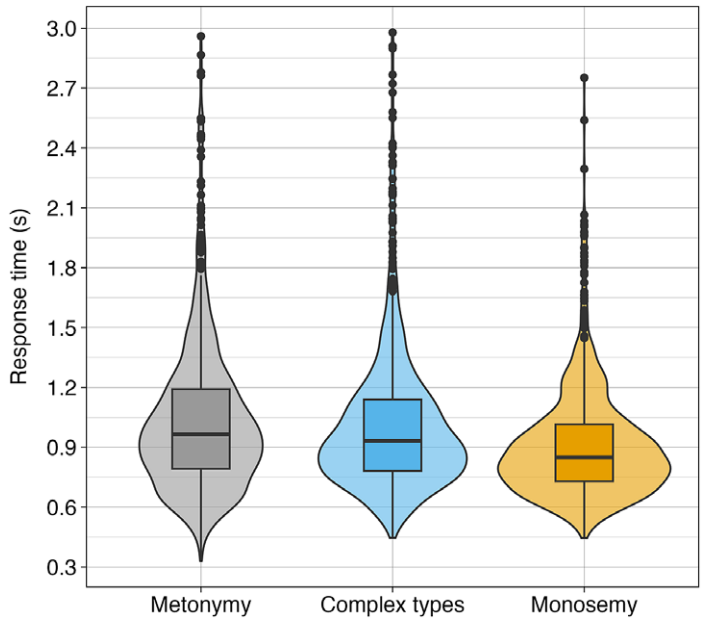

Figure 5. Distribution of response times per ambiguity type.

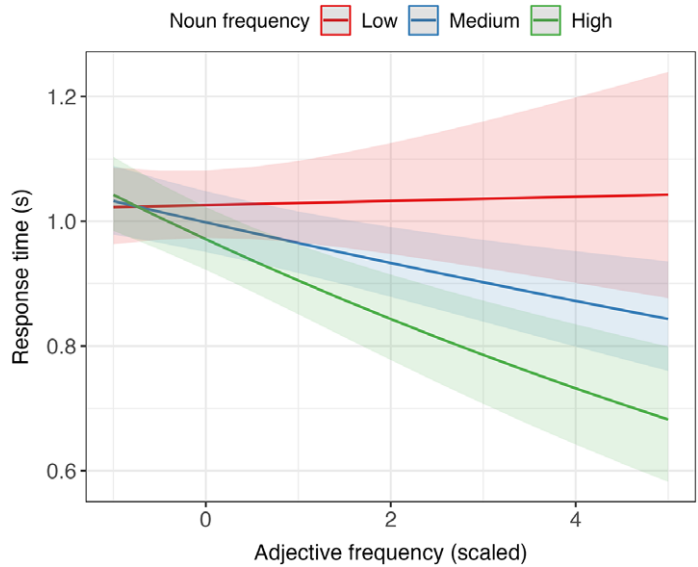

Figure 6. Interaction effect of adjective and noun frequencies in the regression model predicting response times.

dominance and ambiguity type included a by-item random intercept and a by-participant random slope for ambiguity type.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Table 4. Pairwise comparisons between ambiguity types in the regression model predicting correct response times

Contrast	Estimate	*SE*	*z*-value	*p*-value
Metonymy – Complex types	0.02978	0.02222	1.340	.373
Monosemy – Complex types	−0.11173	0.02248	−4.970	< .001
Monosemy – Metonymy	−0.14152	0.02205	−6.419	< .001

5. Discussion

Our experimental results shed light on the semantic representation of complex types. The judgements about semantic sameness collected in Experiment 1 provide an indication of the similarity between complex types and monosemy. Speakers mostly assess the different interpretations of complex-type words as falling under the same lexical meaning, which can be explained by their uniqueness of reference. Complex types can be viewed as describing different ontological aspects of single entities and this denotation can lead to judgements of semantic identity, even when comparing contexts in which different referential facets are focused on. Possible uniqueness of reference makes complex types very similar to monosemy in speakers' minds and clearly distinguishes complex types from polysemy (including regular metonymy) in semantic representation.

The similarity between complex types and monosemy, as opposed to metonymy, is confirmed by response accuracy in Experiment 2. Speakers asked to evaluate promptly the sensicality of adjective-noun phrases do not make significantly more errors when switching between different interpretations of complex-type words than when considering different uses of monosemous words. Metonymic words, on the other hand, cause more errors than both complex-type and monosemous words. Error rates may be influenced by the relatedness between the different senses of a word. The more related two word senses are, the easier will be the process of defocusing on one word sense and refocusing on the other, and the more accurate will be the sensicality judgement. Accordingly, higher response accuracy indicates higher semantic integration. The fact that accuracy does not significantly differ between complex types and monosemy indicates that complex types are very similar to monosemy in terms of unified semantic representation. To put it differently, the semantic activation in priming does not have the same effect for complex-type and metonymic words because of differences in their semantic structure and in the tightness of the relationship between their different interpretations. The semantic integration of complex types inferred from response accuracy can be directly related to judgements of semantic sameness, since unified semantic representations are associated with both single referential representations and notions of identical meaning.

Sameness judgements in Experiment 1 and response accuracy in Experiment 2 are consistent in showing that complex types pattern more with monosemy than with polysemy. Nevertheless, complex types are not equivalent to monosemy, since correct response times for complex types in Experiment 2 are comparable to those of metonymic words and are significantly different from those of monosemous words. This apparently conflicting result reveals the ambiguous nature of complex-type words. Generally speaking, reaction times and accuracy are linked to different psychological mechanisms, and they can exhibit different relationship patterns

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

(see, e.g., Van Maanen et al., 2019). In the sensicality task, response times and accuracy correlate with different dimensions of lexical representations. While response accuracy depends on semantic integration and relatedness, correct response times are related to the multiplicity of interpretation. Differences in response times can be explained by the cognitive effort required to change interpretations (as opposed to not changing interpretations). The response times observed in Experiment 2 indicate that switching from one interpretation to another is costly for both complex-type and metonymic words. It follows that, although complex-type words are very similar to monosemous words in their semantic representation, they cannot be assimilated into them as they still share with polysemous words the property of being associated with different semantic types.

Taken together, our experimental results capture the distinctive nature of complex types. Complex types resemble metonymy in that they involve multiple interpretations. However, their different senses are more closely related than in the case of metonymy, to the point that they can coexist in a single semantic representation and be regarded as denoting different aspects of the same referent – which makes complex types very similar to monosemy. On the continuum of lexical ambiguity, complex types lie close to monosemy without being identical to prototypical monosemous words, that is, single-type words, because of their composite meaning. The fact that complex types are closer to monosemy than to metonymy is supported by the convergence between complex types and monosemy in the uniqueness of reference and unified semantic representation, which are decisive factors in the definition of ambiguity types.

It follows from these observations that complex types can be viewed as having one single meaning that combines two or more semantic types in a unique lexical entry. This lends credence to the approach adopted by Cruse (1995, 2000) and Croft and Cruse (2004), who consider complex types as single gestalts that encompass different semantic aspects (or semantic 'facets'). Indeed, our findings challenge the standard view that complex types are a form of polysemy. Although complex types are based on recurrent associations between different semantic types, they do not belong to regular polysemy. It appears that the distinctive features of complex types – such as the absence of derivation between semantic types, the restriction to the nominal class, or less diversity in type association than regular metonymy – are correlated to a specific semantic representation that differentiates complex types from metonymy. Some of the distinctive features of complex types can actually be observed in our experimental data, such as the homogeneity of complex-type patterns with respect to sameness judgements which contrasts with the heterogeneity of regular metonymy patterns.

More generally, the investigation of complex types questions the difference between semantic types and semantic features, which is central to the definition of complex types. The difference in response time in Experiment 2 points to a qualitative difference between types and features. Although different semantic features of monosemous words can be focused on in prime and target phrases, such as physical and psychological properties for animates (*libraire âgé* 'elderly bookseller' vs. *libraire gentil* 'friendly bookseller') or temporal and causative properties for events (*canicule précoce* 'early heatwave' vs. *canicule étouffante* 'sweltering heatwave'), the time required to switch from one referential aspect to the other is significantly shorter for monosemous than for complex-type words. A major difference between semantic types and semantic features is that the former can categorise whole lexical meanings. They are more autonomous semantically and can be regarded as bundles of features, grouped

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

together in a holistic perspective to describe types of entities. Words can instantiate them independently (e.g., *stone* as PHYSICAL OBJECT, *idea* as INFORMATIONAL CONTENT), which is not the case for semantic features – except, of course, for the words that name the features. As a consequence, complex types are not reducible to semantic features, but are descriptions of the dual nature of the entities they denote.

Further, combined observations from Experiments 1 and 2 seem to support a referential approach to lexical semantics. Possible copredication for words like *book* has led some authors to argue that referential semantics should be abandoned, given that it is exposed to conflicting truth conditions (see Chomsky, 2000; Collins, 2009, 2017; Pietroski, 2005, 2018; Yalcin, 2014; a.o.). However, judgements of semantic sameness in Experiment 1 can hardly be explained without assuming that complex-type words refer to single entities. Similarly, it seems difficult to account for comparable response accuracy between complex-type and monosemous words in Experiment 2 if lexical meanings are not oriented toward reference. By contrast, the idea that monosemous and complex-type words both refer to single entities provides a plausible explanation for their semantic similarity. It seems that both in terms of representation and accessibility, the specific nature of complex-type words can only be fully understood by taking into consideration their referential properties.

Another aspect of our findings is that they may contribute to current knowledge about the processing and mental representation of words with multiple senses. First, our experimental results are consistent with conclusions drawn from the few psycholinguistic studies that have focused on complex-type words, as representative of words with related senses (see Section 2.2). The similarity between complex types and monosemy has been observed by Frazier and Rayner (1990) in a reading experiment. In contrast with sentences containing homonyms, sentences containing complex-type words were read as fast as sentences containing unambiguous words, and neither the position of the disambiguating context (before or after the target word) nor the dominance of selected word senses had an effect on their processing. Beyond differences in experimental paradigms, these results are congruent with our own in revealing a close resemblance between complex types and monosemy. The cognitive cost of switching interpretations for complex-type words has been explored by Frisson (2015) in his study of *book*-type nouns. In a priming experiment involving a sensicality task, the author reported longer response times when the target sense differed from the prime sense than when they were identical. This result is consistent with the difference we observed in response times between complex types and monosemy in Experiment 2. Furthermore, Frisson (2015) did not find any difference in error rates between same-sense and different-sense prime-target pairs, which echoes the results we obtained for response accuracy in Experiment 2. These observations also confirm that accuracy and response times reveal different dimensions of the representation of complex types, and that only response times are influenced by the multiplicity of interpretations of complex-type words. Our conclusions are therefore in line with results from previous studies, indicating that complex types are very similar to monosemy but still differ from it in having multiple interpretations that require extra cognitive effort in lexical processing.

It remains true that complex types have been frequently mixed with polysemy in the literature, and this lack of distinction can lead to inconclusive or conflicting results. For instance, Haber and Poesio (2020, 2021) in their studies on polysemy and homonymy included both complex-type and metonymic nouns in the category of polysemes. They observed a discrepancy between the similarity and copredication

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

judgements for polysemes, but this may be actually explained by the failure to distinguish between the two types of ambiguous words. Similarly, when investigating the effect of sense dominance on the processing of polysemous words, Foraker and Murphy (2012) and Klepousniotou et al. (2008) grouped together complex-type and metonymic words, which prevents comparison between their results and those of Frisson (2015) – whether the results seem consistent or not. As noted by Brocher et al. (2018), Eddington and Tokowicz (2015), and Lopukhina et al. (2018), some apparently contradictory results in psycholinguistic studies on ambiguity can be explained by differences in linguistic materials and lack of control over the words used to represent the different categories of ambiguity. Most certainly, our results advocate for a clear distinction between complex types and metonymy in experimental materials, not to mention other types of polysemy.

The differences we found between complex types and metonymy call for an appropriate model of mental representations of ambiguity, which would be able to account for the specific nature of complex types. As mentioned above, we can hypothesise that complex types are associated with unique lexical entries, given their similarity with monosemous words. However, these unique entries differ from those of monosemous words in that they integrate different facets of meaning. Such entries could be viewed as semantically underspecified, insofar as they encompass different senses without the need to distinguish between them. Underspecification accounts have been proposed for polysemous words in general, both in theoretical and psycholinguistic research. Underspecification can be conceived of in many different forms, from thin semantic representations to large meaning potentials that are further specified in context (Allwood, 2003; Carston, 2012; Evans, 2009; Recanati, 2004; Vicente, 2018; a.o.). Experimental findings suggest that polysemous words may initially activate an underspecified abstract representation that includes all established senses, before being fully processed (Frisson, 2009; Frisson & Pickering, 1999, 2001; Li & Slevc, 2017; a.o.). However, underspecification models should be able to accommodate the differences between polysemy and complex types. The question remains open as to what kind of mental representations we can postulate for the different types of words with related but incompatible senses. In any case, representational models of ambiguous words should include specific elements of description that can account for the distinctive nature of complex-type words.

6. Conclusion

The aim of this study was to determine the nature of complex semantic types with respect to lexical ambiguity. On the one hand, the status of complex-type words as polysemous or monosemous words is controversial in theoretical linguistics. On the other hand, although ambiguous words are known to be heterogeneous in terms of cognitive processing and mental representation, psycholinguistic studies on lexical ambiguity have rarely investigated complex types as such. In this study, we attempted to both answer theoretical research questions about the nature of complex types and disentangle previous experimental findings about the lexical representation of ambiguous words.

To do so, we conducted two experiments involving judgements of semantic sameness and semantic priming. Assuming a continuum of ambiguity ranging from homonymy to monosemy, we showed that complex types are closer to monosemy

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

than to metonymy. Complex types share with monosemy the property of having a single meaning and a unified semantic representation, arguably related to a unique reference. Nevertheless, complex types are not reducible to monosemy, because they integrate different semantic facets that can be independently selected in contextual interpretation. Ultimately, their complex nature relies on the autonomy of semantic types, as opposed to semantic features.

These results support the view that complex types are associated with a single underspecified entry in the mental lexicon. Moreover, they highlight the need for representational models of ambiguous words that can account for the difference between complex types and metonymy. Future research should test such possible models and contrast metonymy and complex types in a variety of experimental paradigms, in order to refine our understanding of the different forms of lexical ambiguity.

Data availability statement. The linguistic materials, datasets, and statistical scripts used in this study are available at https://osf.io/pjvxg/.

Acknowledgments. This research was partially funded by the Swiss National Science Foundation under grant 10001F_188782. We are grateful to Stefan Hartmann and two anonymous reviewers for their helpful and constructive comments on an earlier version of this paper. All remaining errors are our own.

Ethics and consent. All experiments have been approved by the Ethics Committee of the University of Fribourg (Request #2023-837), and all participants have provided written informed consent before participating in the study.

References

Allwood, J. (2003). Meaning potentials and context: Some consequences for the analysis of variation in meaning. In H. Cuyckens, R. Dirven, & J. R. Taylor (Eds.), *Cognitive approaches to lexical semantics* (pp. 29–66). Mouton de Gruyter.

Apresjan, J. D. (1974). Regular polysemy. *Linguistics*, 12(142), 5–32.

Arapinis, A., & Vieu, L. (2015). A plea for complex categories in ontologies. *Applied Ontology*, 10(3–4), 285–296.

Asher, N. (2011). *Lexical meaning in context: A web of words*. Cambridge University Press.

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), 255–278.

Bates, D., Maechler, M., Bolker, B., and Walker, S. (2014). *lme4: Linear mixed effects models using Eigen and S4. r package version 1.1–6.* http://CRAN.R-project.org/package=lme4

Beretta, A., Fiorentino, R., & Poeppel, D. (2005). The effects of homonymy and polysemy on lexical access: An meg study. *Cognitive Brain Research*, 24(1), 57–65.

Brocher, A., Foraker, S., & Koenig, J. P. (2016). Processing of irregular polysemes in sentence reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 42, 1798–1813.

Brocher, A., Koenig, J. P., Mauner, G., & Foraker, S. (2018). About sharing and commitment: The retrieval of biased and balanced irregular polysemes. *Language, Cognition and Neuroscience*, 33(4), 443–466.

Brown, S. W. (2008). Polysemy in the mental lexicon. *Colorado Research in Linguistics*, 21, 1–12.

Carston, R. (2012). Word meaning and concept expressed. *The Linguistic Review*, 29(4), 607–623.

Chomsky, N. (2000). *New horizons in the study of language and mind*. Cambridge University Press.

Collins, J. (2009). Methodology, not metaphysics: Against semantic externalism. *Aristotelian Society Supplementary Volume*, 83(1), 53–69.

Collins, J. (2017). The copredication argument. *Inquiry*, 60(7), 675–702.

Copestake, A., & Briscoe, T. (1995). Semi-productive polysemy and sense extension. *Journal of Semantics*, 12 (1), 15–67.

Croft, W., & Cruse, D. A. (2004). *Cognitive linguistics*. Cambridge University Press.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Cruse, D. A. (1995). Polysemy and related phenomena from a cognitive linguistic viewpoint. In P. Saint-Dizier, & E. Viegas (Eds.), *Computational lexical semantics. Studies in natural language processing* (pp. 33–49). Cambridge University Press.

Cruse, D. A. (2000). Lexical "facets": Between monosemy and polysemy. In S. Beckmann, P. P. König, & T. Wolf (Eds.), *Sprachspiel und Bedeutung: Festschrift für Franz Hundsnurscher zum 60 Geburtstag* (pp. 25–36). Max Niemeyer Verlag.

Cruse, D. A. (2004). Lexical facets and metonymy. *Ilha do Desterro*, 47, 73–96.

Dölling, J. (2020). Systematic polysemy. In D. Gutzmann, L. Matthewson, C. Meier, H. Rullmann, & T. E. Zimmermann (Eds.), *The Wiley Blackwell companion to semantics* (pp. 1–27). Wiley.

Duek Silveira Bueno, K. (2017). *Sorting a complex world: An experimental study of polysemy and copredication in container and committee nominals* [PhD thesis]. UC Santa Cruz.

Duffy, S. A., Morris, R. K., & Rayner, K. (1988). Lexical ambiguity and fixation times in reading. *Journal of Memory and Language*, 27, 429–446.

Eddington, C. M., & Tokowicz, N. (2015). How meaning similarity influences ambiguous word processing: The current state of the literature. *Psychonomic Bulletin & Review*, 22(1), 13–37.

Erk, K., McCarthy, D., & Gaylord, N. (2009). Investigations on word senses and word usages. In *Proceedings of the joint conference of the 47th annual meeting of the ACL and the 4th international joint conference on natural language processing of the AFNLP* (pp. 10–18). Association for Computational Linguistics.

Evans, V. (2009). *How words mean: Lexical concepts, cognitive models, and meaning construction*. Oxford University Press.

Falkum, I., & Vicente, A. (2015). Polysemy: Current perspectives and approaches. *Lingua*, 157, 1–16.

Foraker, S., & Murphy, G. L. (2012). Polysemy in sentence comprehension: Effects of meaning dominance. *Journal of Memory and Language*, 67(4), 407–425.

Fox, J., & Weisberg, S. (2019). An R companion to applied regression, third edition. Sage. https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Frazier, L., & Rayner, K. (1990). Taking on semantic commitments: Processing multiple meanings vs. multiple senses. *Journal of Memory and Language*, 29(2), 181–200.

Frisson, S. (2009). Semantic underspecification in language processing. *Language and Linguistics Compass*, 3 (1), 111–127.

Frisson, S. (2015). About bound and scary books: The processing of book polysemies. *Lingua*, 157, 17–35.

Frisson, S., & Pickering, M. J. (1999). The processing of metonymy: evidence from eye movements. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 25(6), 1366–1383.

Frisson, S., & Pickering, M. J. (2001). Obtaining a figurative interpretation of a word: Support for underspecification. *Metaphor and Symbol*, 16(3–4), 149–171.

Haber, J., & Poesio, M. (2020). Assessing polyseme sense similarity through co-predication acceptability and contextualised embedding distance. In *Proceedings of the ninth joint conference on lexical and computational semantics* (pp. 114–124). Association for Computational Linguistics.

Haber, J. and Poesio, M. (2021). Patterns of lexical ambiguity in contextualised language models. In *Findings of the association for computational linguistics: EMNLP 2021* (pp. 2663–2676). Association for Computational Linguistics.

Hothorn, T., Bretz, F., Westfall, P., Heiberger, R. M., Schuetzenmeister, A., and Scheibe, S. (2017). *Simultaneous inference in general parametric models. R package 'multcomp', version 1.4-8.* http://multcomp.R-forge.R-project.org

Jezek, E. and Vieu, L. (2014). Distributional analysis of copredication: Towards distinguishing systematic polysemy from coercion. In A. Lenci and B. Magnini (Eds.), *Proceedings of the first Italian conference on computational linguistics CLiC-it 2014 & the fourth international workshop EVALITA 2014* (Vol. 1, pp. 219–223).

Johnson, P. (2014). Extension of Nakagawa and Schielzeth's r2 glmm to random slopes models. *Methods in Ecology and Evolution*, 5, 944–946.

Klein, D. E., & Murphy, G. L. (2001). The representation of polysemous words. *Journal of Memory and Language*, 45(2), 259–282.

Klein, D. E., & Murphy, G. L. (2002). Paper has been my ruin: Conceptual relations of polysemous senses. *Journal of Memory and Language*, 47(4), 548–570.

Klepousniotou, E. (2002). The processing of lexical ambiguity: Homonymy and polysemy in the mental lexicon. *Brain and language*, 81, 205–223.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Klepousniotou, E., & Baum, S. (2007). Disambiguating the ambiguity advantage effect in word recognition: An advantage for polysemous but not homonymous words. *Journal of Neurolinguistics*, 20(1), 1–24.

Klepousniotou, E., Pike, G. B., Steinhauer, K., & Gracco, V. (2012). Not all ambiguous words are created equal: An eeg investigation of homonymy and polysemy. *Brain and language*, 123(1), 11–21.

Klepousniotou, E., Titone, D., & Romero, C. (2008). Making sense of word senses: The comprehension of polysemy depends on sense overlap. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 34(6), 1534–1543.

Li, L., & Slevc, L. R. (2017). Of papers and pens: Polysemes and homophones in lexical (mis) selection. *Cognitive Science*, 41, 1532–1548.

Liebesman, D., & Magidor, O. (2017). Copredication and property inheritance. *Philosophical Issues*, 27, 131–166.

Löhr, G., & Michel, C. (2022). Copredication in context: A predictive processing approach. *Cognitive science*, 46(5), 1–27.

Lombard, A., Huyghe, R., Barque, L., & Gras, D. (2023). Regular polysemy and novel word-sense identification. *The Mental Lexicon*, 18(1), 94–119.

Lombard, A., Huyghe, R., & Gygax, P. (2021). Neological intuition in French: A study of formal novelty and lexical regularity as predictors. *Lingua*, 254, 1–17.

Lopukhina, A., Laurinavichyute, A., Lopukhin, K., & Dragoy, O. (2018). The mental representation of polysemy across word classes. *Frontiers in Psychology*, 9, 1–16.

Lukic, S., Meltzer-Asscher, A., Higgins, J., Parrish, T. B., & Thompson, C. K. (2019). Neurocognitive correlates of category ambiguous verb processing: The single versus dual lexical entry hypotheses. *Brain and Language*, 194, 65–76.

MacGregor, L. J., Bouwsema, J., & Klepousniotou, E. (2015). Sustained meaning activation for polysemous but not homonymous words: Evidence from EEG. *Neuropsychologia*, 68, 126–138.

Maciejewski, G. (2018). *Representation and processing of semantic ambiguity* [PhD thesis]. University of Leeds.

Matuschek, H., Kliegl, R., Vasishth, S., Baayen, H., & Bates, D. (2017). Balancing Type I error and power in linear mixed models. *Journal of Memory and Language*, 94, 305–315.

McCarthy, D., Apidianaki, M., & Erk, K. (2016). Word sense clustering and clusterability. *Computational Linguistics*, 42(2), 245–275.

Murphy, E. (2021a). *Linguistic representation and processing of copredication* [PhD thesis]. University College London.

Murphy, E. (2021b). Predicate order and coherence in copredication. *Inquiry*, 1–37, https://www.tandfonline.com/doi/full/10.1080/0020174X.2021.1958054.

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R^2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution*, 4(2), 133–142.

New, B., Pallier, C., Brysbaert, M., & Ferrand, L. (2004). Lexique 2: A new French lexical database. *Behavior Research Methods, Instruments, & Computers*, 36(3), 516–524.

Nunberg, G. (1995). Transfers of meaning. *Journal of Semantics*, 12(2), 109–132.

Ortega-Andrés, M., & Vicente, A. (2019). Polysemy and co-predication. *Glossa: A Journal of General Linguistics*, 4(1), 1–23.

Partee, B. H., & Borschev, V. (2012). Sortal, relational, and functional interpretations of nouns and Russian container constructions. *Journal of Semantics*, 29, 445–486.

Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, 51(1), 195–203.

Pietroski, P. (2005). Meaning before truth. In G. Preyer & G. Peter (Eds.), *Contextualism in philosophy: Knowledge, meaning, and truth* (pp. 255–300). Oxford University Press.

Pietroski, P. M. (2018). *Conjoining meanings: Semantics without truth values*. Oxford University Press.

Pustejovsky, J. (1995). *The generative lexicon*. MIT Press.

Pylkkänen, L., Llinás, R., & Murphy, G. L. (2006). The representation of polysemy: MEG evidence. *Journal of Cognitive Neuroscience*, 18(1), 97–109.

R Core Team (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Rabagliati, H., & Snedeker, J. (2013). The truth about chickens and bats: Ambiguity avoidance distinguishes types of polysemy. *Psychological Science*, 24(7), 1354–1360.

https://doi.org/10.1017/langcog.2023.73 Published online by Cambridge University Press

Recanati, F. (2004). *Literal meaning*. Cambridge University Press.
Rodd, J. M., Berriman, R., Landau, M., Lee, T., Ho, C., Gaskell, M. G., & Davis, M. H. (2012). Learning new meanings for old words: Effects of semantic relatedness. *Memory & Cognition*, 40, 1095–1108.
Rodd, J. M., Gaskell, M. G., & Marslen-Wilson, W. D. (2002). Making sense of semantic ambiguity: Semantic competition in lexical access. *Journal of Memory and Language*, 46, 245–266.
Schäfer, R. (2015). Processing and querying large web corpora with the COW14 architecture. In *Proceedings of the 3rd workshop on challenges in the management of large corpora* (pp. 28–34). IDS publication.
Schäfer, R., & Bildhauer, F. (2012). Building large corpora from the web using a new efficient tool chain. In *Proceedings of the tenth international conference on language resources and evaluation* (pp. 486–493). European Language Resources Association.
Trott, S. (2022). *Ambiguity in the mind and the lexicon* [PhD thesis]. University of California.
Trott, S., & Bergen, B. (2021). RAW-C: Relatedness of ambiguous words in context (a new lexical resource for English). In *Proceedings of the 59th annual meeting of the association for computational linguistics and the 11th international joint conference on natural language processing* (Vol. 1, pp. 7077–7087). Association for Computational Linguistics.
Trott, S., & Bergen, B. (2023). Word meaning is both categorical and continuous. *Psychological Review*, 130 (5), 1239–1261.
Van Maanen, L., Katsimpokis, D., & van Campen, A. D. (2019). Fast and slow errors: Logistic regression to identify patterns in accuracy–response time relationships. *Behavior Research Methods*, 51, 2378–2389.
Vicente, A. (2018). Polysemy and word meaning: An account of lexical meaning for different kinds of content words. *Philosophical Studies*, 175(4), 947–968.
Vicente, A. (2021). Approaches to co-predication: Inherent polysemy and metaphysical relations. *Journal of Pragmatics*, 182, 348–357.
Yalcin, S. (2014). Semantics and metasemantics in the context of generative grammar. In *Metasemantics: New essays on the Foundations of Meaning* (Vol. 17). Oxford Academic.
Yurchenko, A., Lopukhina, A., & Dragoy, O. (2020). Metaphor is between metonymy and homonymy: Evidence from event-related potentials. *Frontiers in Psychology*, 11, 1–12.

Cite this article: Huyghe, R., Barque, L., Delafontaine, F., & Salvadori, J. (2024). The ambiguous nature of complex semantic types: an experimental investigation, *Language and Cognition*, 1–26. https://doi.org/10.1017/langcog.2023.73