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The Spectrum of Sense Remoteness in Polysemy: Bridging Computational and Theoretical Lexicography with Psycholinguistics (Part 1)

Abstract
This two-part paper bridges insights from psycholinguistics and from theoretical and computational lexicography to develop a fine-grained classification of polysemy organized along a wider spectrum of sense remoteness of ambiguous words in Polish based on the investigation of a large collection of linguistic data.[1] In the first part, we equip readers with background knowledge on different psycholinguistic views on polysemy and we introduce the basic spectrum of sense remoteness proposed in earlier literature. We also present the methodology of our research and we report the results of our quantitative study based on a large sample of sense pairs randomly extracted from plWordNet

[1] As pointed out by an anonymous reviewer, the presented study does not report any psycholinguistic experiments but it employs psycho-linguistic concepts in the explanation of the annotation of the data, which can render the study part of the psycholinguistics literature.

(Słowosieć) thanks to the resources received from the CLARIN-PL Language Technology Center (the Polish section of the European research infrastructure CLARIN ERIC). We show that the most widely represented polysemy types are nested polysemy, polysemy by metaphor and polysemy by metonymy. The second part proposes an extended spectrum of sense remoteness and presents insights on different types of polysemy included in this spectrum with a special attention paid to nested polysemy.

Keywords
polysemy, spectrum of sense remoteness, plWordNet – Słowosieć, Polish, mental lexicon, homonymy, metonymy, metaphor, nested polysemy

Abstrakt
Ten dwuczęściowy artykuł konsoliduje fakty dotyczące polisemii z zakresu psycholingwistyki oraz leksykografii teoretycznej i obliczeniowej oraz prezentuje wyniki badań ilościowych i jakościowych przeprowadzonych na dużym zbiorze danych polisemicznych w języku polskim, na podstawie których proponujemy uszczegółowioną klasyfikację polisemii oraz opracowujemy poszerzone spektrum podobieństwa sensów słów wieloznacznych. W pierwszej części publikacji omówiono psycholingwistyczne modele reprezentacji polisemii w mentalnym leksykonie oraz wprowadzono podstawowe spektrum podobieństwa sensów, zaproponowane w literaturze przedmiotu. Przedstawiono też metodologię oraz wyniki badań ilościowych przeprowadzonych dla par sensów wyrazów polisemicznych losowo wybranych ze Słowosieci i pozyskanych dzięki wsparciu Centrum Technologii Językowych CLARIN-PL (polskiej sekcji europejskiej infrastruktury badawczej CLARIN ERIC). Wyniki naszego badania pokazują, że najczęściej reprezentowaną polisemią są następujące typy: polisemia gniazdowa, polisemia przez metaforę i polisemia przez metonimię. W drugiej części publikacji poszerzamy spektrum podobieństwa sensów i uszczegóławiamy klasyfikację polisemii na podstawie badania jakościowego. Przedstawiamy także nowe obserwacje na temat różnych typów polisemii wchodzących w skład tego spektrum, ze szczególnym uwzględnieniem polisemii gniazdowej.

Słowa kluczowe
polisemia, spektrum podobieństwa sensów, plWordNet – Słowosieć, język polski, mentalny leksykon, homonimia, metonimia, metafora, polisemia gniazdowa

1. Main goal

The goal of this study is to contribute to a recent line of theoretical as well as psycho- and neurolinguistic research on the representation of ambiguous (homonymous and polysemous) words in the mental lexicon by positing a fine-grained classification of polysemy organized along a spectrum of sense remoteness.

There have been many studies on how homonymous words are represented in the memory (e.g., Swinney 1979; Van Petten and Kutas 1987; Azuma and Van Orden 1997; Hino and Lupker 1996; Rayner and Duffy 1986; Beretta, Fiorentino and Poeppel 2005). Recently, there has been a growing interest in polysemy, but the results of the existing studies are far from uniform

(e.g., Pickering and Frisson 2001; Klein and Murphy 2001, 2002; Pylkkänen, Llinás and Murphy 2006; Falkum 2010, 2011; Foraker and Murphy 2012; Falkum and Vicente 2015; Frisson 2015; Brocher, Foraker and Koenig 2016; Brocher et al. 2018; Carston 2020; Murphy 2021). While there is a general consensus that the meanings of homonymous words are represented as different lexemes in the mental lexicon, the views on how polysemous words are represented vary. An important reason for why scholars cannot reach consensus as to how polysemy is represented in the mental lexicon is that polysemy is a multifarious phenomenon and different kinds of polysemy may have different representations in the mental lexicon giving rise to different experimental results (see also Falkum and Vicente 2015; Brocher, Foraker and Koenig 2016; Carston 2020). One important parameter along which polysemy varies is sense remoteness. Klepousniotou and Baum (2007), Klepousniotou, Titone and Romero (2008), Klepousniotou et al., (2012) provided experimental evidence that the degree of semantic similarity (also referred to as semantic remoteness or semantic overlap) between different meanings or senses of ambiguous words affects their processing. Similarly, Apresjan, Lopukhina and Zarifyan (2021) show in their recent study that adjectival metonymy is heterogeneous as to its mental storage depending on sense remoteness. Our goal is to extend this line of research by developing a fine-grained classification of polysemy organized along a wider spectrum of sense remoteness of ambiguous words in Polish based on the investigation of a wide spectrum of data. Such an approach has a potential to significantly enrich our understanding of polysemy and its representation in memory and it may have important applications in further psycho- and neurolinguistic research. An important contribution of this study is that we attempt to bridge insights from computational and theoretical lexicography with an ongoing psycholinguistic discussion on the representation of polysemy in the memory.

The paper has the following organization. It is divided into two parts: Part 1 and Part 2. Part 1 comprises sections 1–2 and Part 2 comprises sections 3–5. In section 2, we overview the prevailing psycholinguistic views on homonymy and polysemy and we introduce the notion of sense remoteness as a parameter of variation of polysemy. We also present the basic spectrum of sense remoteness proposed in the literature. In Section 3, we present the methodology of our research on polysemy in which we relied on the services, tools and resources of the CLARIN-PL Language Technology Center (the Polish section of the European research infrastructure CLARIN ERIC). We also present the results of our quantitative research on the frequency of occurrence of different types of polysemy in a randomly selected sample of sense pairs. In Section 4, we present our insights on nested polysemy, which has so far received very little attention in research on polysemy but which turned out to be the most widely represented in our sample. Section 5

discusses some examples of polysemy which can be perceived either as homonymy or as metaphor, metonymy, nested polysemy by different language users. We dub this class 50/50. We also propose an extended spectrum of sense remoteness. In Section 6, we present our insights on metaphor and metonymy and we suggest that the distinguished types of metonymy and metaphor may differ with respect to sense remoteness, which in turn may affect the way they are represented in the mental lexicon.

2. Relevant background on polysemy

2.1. Psycholinguistic and theoretical approaches to polysemy representation in the mind

There are two basic types of lexical ambiguity: homonymy and polysemy.

We define the homonymy/polysemy distinction using a semantic criterion based on the degree of semantic similarity. Homonyms are strings of letters (or phonemes) which can be assigned two or more semantically unrelated meanings (Valera and Ruz 2021), as exemplified for Polish in (1)[2].

(1)

a. *sprawna* AKCJA 'a smooth action' vs. *giełdowa* AKCJA 'a stock market share'
b. *wojskowy* GAZIK 'a military car' vs. *jałowy* GAZIK 'a sterile gauze pad'
c. *karnawałowy* BAL 'a carnival ball' vs. *sosnowy* BAL 'a pine wood log'
d. *pełny* GRAFIK 'a full schedule' vs. *zdolny* GRAFIK 'a talented graphic designer'
e. *baśniowy* SEZAM 'fairy-tale Sesame' vs. *łuskany* SEZAM 'shelled sesame'
f. *wielkanocna* BABKA 'Easter cake' vs. *ślepa* BABKA 'a blind old woman'
g. *ciasny* BOKS 'a cramped cubicle' vs. *amatorski* BOKS 'amateur boxing'
h. *ciepła* KAWKA 'hot coffee' vs. *ćwierkająca* KAWKA 'a chirping jackdaw'
i. *rozłożysty* KLON 'a spreading maple' vs. *ludzki* KLON 'a human clone'
j. *cielęca* PARÓWKA 'a veal sausage' vs. *ziołowa* PARÓWKA 'herbal steam bath'
k. *światowy* POKÓJ 'world peace' vs. *hotelowy* POKÓJ 'a hotel room'
l. *rozszerzony* POR 'an enlarged pore' vs. *pokrojony* POR 'chopped leek'
m. *jabłkowy* MUS 'apple mousse' vs. *bezwzględny* MUS 'an absolute must'
n. *buchająca* PARA 'gushing vapour' vs. *zakochana* PARA 'a couple in love'

By contrast, polysemous words have multiple semantically related senses, as exemplified in (2) for Polish.

[2] All the adjective collocations are used to disambiguate each of the senses. To select proper adjective collocations we resorted to a Word Sketch collocator (an innovative NLP tool operating on large-scale corpora) embedded under Sketch Engine available at http://www.sketchengine.eu (Kilgarriff et al. 2014) and the PELCRA collocator (Pęzik, 2012; Janus, Przepiórkowski 2007) embedded under the National Corpus of Polish.

(2)

a. *Nad Zatoką Pucką przeszła niespodziewana TRĄBA powietrzna.*
'An unexpected *whirlwind* passed over the Bay of Puck.'

b. *Głośno zagrał na blaszanej TRĄBIE.*
'He played the tin *trumpet* loudly.'

c. *Ale z ciebie TRĄBA.*
'You're a real *dumbo*.'

d. *TRĄBA służy słoniowi do polewania się wodą.*
'The *trunk* is used by the elephant to pour water on itself.'

The single word *trąba* in Polish can be used to refer to a whirlwind, as in (2a), to a trumpet, as in (2b), to a very clumsy person (a dumbo), as in (2c) or to an elephant trunk, as in (2d). In psycholinguistics, most scholars agree that the meanings of homonymous words are represented as different lexemes in the mental lexicon. Scholars working on the processing of homonymy postulate the *Meaning Enumeration Lexicon*, in which each meaning of a homonymous word is stored under a separate lexical entry. What is controversial, is how different senses of polysemous words are represented in the memory and how they are processed during language comprehension. Concerning homonymy scholars generally agree that there is a competition between meanings and the most frequent meaning usually wins the competition unless there is contextual support for the less frequent meaning. The frequency effects found in homonymy are not always attested in polysemy suggesting that its lexical representation differs from that of homonymy. In psycholinguistic literature, there are three main approaches to polysemy which address these questions differently:

(i) Core Meaning hypothesis, according to which the comprehenders activate a single underspecified abstract semantic representation (core meaning being some kind of summary of all the different senses of the word) when they encountering a polysemous word (see Frazier and Rayner 1990; Frisson and Pickering 1999, 2007; Frisson 2009, 2015; Pickering and Frisson 2001). Scholars postulating this view claim that the comprehenders do not immediately commit to one of the senses of a polysemous word but rather they exploit contextual cues to home in on a particular sense with a delay. In this sense, it is a top-down model of processing in that context is used to gradually home in on the desired interpretation.

(ii) Sense-Enumeration Lexicon approach which posits that different senses of a polysemous word are listed as separate lexical entries in the memory but are connected to a joint core representation (see Klein and Murphy 2001, 2002; Pylkkänen, Llinás and Murphy 2006; Foraker and Murphy 2012). Under this view, the processing of polysemous words should proceed in a bottom-up fashion in that different senses of a polysemous word should become automatically activated and the strength of their activation should depend

on their meaning frequency. In other words, sense dominance should play a role immediately and early effects of sense frequency are expected.

(iii) Relevance Theory-inspired view (due to Falkum 2010, 2011) holds that polysemy is a pragmatic phenomenon and polysemous words are not listed in the lexicon but rather the comprehenders compute them during online processing based on context-driven extension (in top-down processing). According to this approach, all that is represented in the lexicon is a Core Meaning of a polysemous word, and its different polysemous extensions are generated on the fly using pragmatic reasoning and world knowledge. This view says that the comprehenders exploit contextual clues to arrive at the intended reading of a polysemous expression. In the absence of such clues, that is in neutral contexts, they choose the most frequent contextual interpretation. Under this approach, sense frequency should not play a role when a preverbal context supports a specific interpretation of a polysemous word, but it should play a role in neutral contexts. In the latter case the most frequent interpretation is chosen.

Similarly, in theoretical approaches to polysemy, scholars differ in the amount of information associated with a lexical representation of a polysemous lexical item. Under rich meaning approaches, polysemous words are lexically represented as an organized structure where senses are explicitly represented. Pustejovsky (1995) in his Generative Lexicon claims that such knowledge structures are part of lexical meanings. He describes the meaning of lexical elements by means of qualia structures in terms of four roles describing hidden events or activities that are conceptually related to a given word: (i) Constitutive: describing physical characteristics of an object, its parts; (ii) Agentive: focusing on the actions related to the origin of the object; (iii) Formal: describing taxonomic information of an object and (iv) Telic: describing the purpose or function of an object. While solving mismatches we access the hidden events available in the qualia structure of a lexical representation (see also Asher and Pustejovsky 2006, Asher 2011 for a similar view). Similarly, Ortega-Andrés and Vicente (2019) in their discussion of the polysemous nature of the word *school* argue that it links to a knowledge structure that stores the typical senses of the word. They associate knowledge structures with lexical meanings of words. Senses that are part of the structure form an activation package in which the activation of one of the senses causes the activation other senses (see also Ortega-Andrés, 2021). Hogeweg and Vicente (2020: 867) argue that some semantic phenomena can be explained only if we assume a rich lexical representation. These are for example coercion effects which are repair processes arising when there is a mismatch between lexical restrictions of some words and the semantics of other linguistic expressions they are composed with. Coercion processes have been shown to cause repair mechanism which are cognitively costly

and lead to increased processing time. Such phenomena suggest that lexical content of words is semantically rich.

On the other hand, thin semantics approaches such as the one proposed in traditional formal semantics lexical representations consist of simple denotations and it is distinct from conceptual knowledge. Such a clear distinction between lexical meaning of words and conceptual structures associated with them was also proposed by Jackendoff (2002). Bücking and Maienborn (2019), like Jackendoff (2002), assume a strict division between lexical and conceptual knowledge but they agree that both types of knowledge are involved in resolving semantic conflicts. Bücking and Maienborn (2019) argue that Pustejovsky's (1995) qualia structures are too poor to account for the whole range of possible interpretations of lexical items and more knowledge would have to be part of qualia structures to account for the flexibility of word meanings. They also state that if all the relevant world knowledge was part of lexical representations, the compositional system would be in danger of collapsing. Another proponent of a thin semantic approach to polysemy is Dölling (2003, 2005, 2014) who postulates that underspecification is resolved through the insertion of a coercion operator that links lexical content with pragmatic inferencing based on context and world knowledge.

Both thin and rich lexical representation approaches agree that conceptual and world knowledge is used during meaning composition but they disagree as to how much of this knowledge is part of the lexicon.

2.2. Spectrum of sense remoteness as a parameter of variation in polysemy

The reason why scholars cannot agree on how polysemy is represented and processed in the mind is that polysemy itself is not a uniform phenomenon. One important parameter along which polysemy varies is sense remoteness. Haber and Poesio (2020) show that the distinction between homonyms and polysemes is not sufficient and some polysemic sense interpretations are evaluated as significantly less similar to each other than other sense pairs suggesting that polysemy is not a homogenous phenomenon. They suggest that the interpretations of polysemic words might be grouped based on their similarity but they remain agnostic as to whether sense groupings are idiosyncratic or systematic across target words of a certain polysemy type. Similarly, in their studies using subjective judgements, reading time measures and Event Related Potentials, Klepousniotou and Baum (2007), Klepousniotou, Titone and Romero (2008), Klepousniotou et al. (2012) showed that the degree of semantic similarity between different meanings or senses of ambiguous words affects their processing, which may indicate that high sense remoteness words and low sense remoteness words are associated

with different storage profiles in the mental lexicon. They compared three groups of lexically ambiguous words: (i) homonymy, (ii) polysemy by metaphor and (iii) polysemy by metonymy and they proposed the spectrum of their sense remoteness presented in Figure 1.

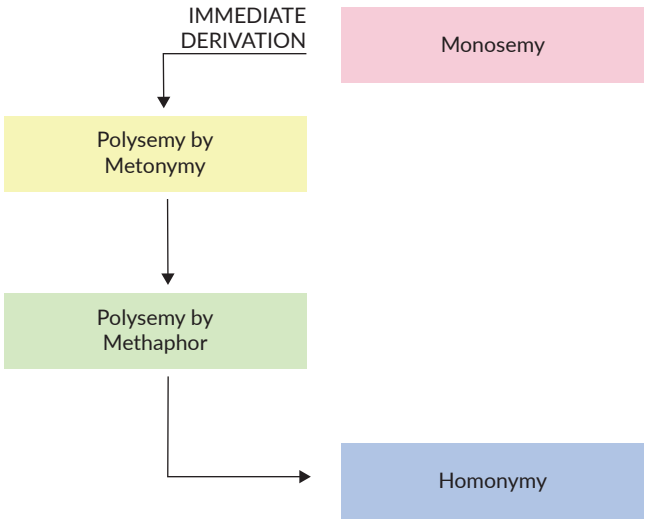

Figure 1: The spectrum of sense remoteness postulated by Klepousniotou and Baum (2007), Klepousniotou, Titone and Romero (2008), Klepousniotou et al. (2012). The graphical representation is ours

Their proposal is consistent with the findings from language development, language comprehension and language deficits research suggesting that metonymy is cognitively more basic and easier to learn and process than metaphor (see Rundblad and Annaz 2010).

Metonymy and metaphor are two very similar mechanisms of meaning extension. In metaphor, this mechanism is based on similarity between two things or concepts while in metonymy it is based on contiguity (see Barnden 2007; Bartsch 2002; Bortfeld and McGlone 2001; Bowdle and Gentner 2005; Coulson and Matlock 2001; Gentner et al. 2001; Annaz et al. 2009; Croft 1993; Dirven 2002; Feyaerts 2003; Klepousniotou 2002; Ortony 1979; Schumacher 2019; Bambini, Bott and Schumacher 2021). Carston (2020: 112) points out that for example, an institution and the building where its activities take place, a container and its contents are metonymic because there is a contiguous relation between them in the real world. By contrast, a human leg and a table leg, a wing of a bird and a wing of a plane share some degree of resemblance either at the conceptual level, at the level of their range of

functions or at the level of symbolic, stereotypical associations. Cognitive linguists describe metonymy as a mechanism of meaning extension which involves two related senses within the same cognitive domain. By contrast, metaphorically used words involve two senses across two conceptual domains (see Kövecses and Radden 1998; Lakoff and Johnson 1980; Lewandowska-Tomaszczyk 2012; Ruiz de Mendoza Ibánez 2003; Spieß and Köpcke 2015; Turner and Fauconnier 2003; Michl 2019). The notion of the domain has, however, not been unequivocally defined.

Polysemy by metonymy is typically regular. The regularity of polysemous words has been captured by Apresjan (1974: 181) who used the following criterion to characterize regular polysemy: 'Polysemy of the word A with the senses a_i and a_j is regular if, in a given language, there exists at least one other word B with the meanings b_i and b_j, which are semantically distinct in exactly the same way as a_i and a_j and if a_i and b_i, a_j and b_j are non-synonymous.' Apresjan (1974) divided regular polysemy into classes, which mainly instantiate metonymy, as exemplified in (3).

(3)

a. animal/meat e.g., *kurczak* 'chicken', *indyk* 'turkey'
   pyszny KURCZAK 'delicious chicken' vs. *puszysty* KURCZAK 'a fluffy chicken'
b. type of tree/wood from this type of tree e.g., *dąb* 'oak', *sosna* 'pine'
   rozłożysty DĄB 'a spreading oak tree' vs. *sękaty* DĄB 'gnarled oak wood'
c. container/unit of measure e.g., *butelka* 'bottle', *szklanka* 'glass'
   zbita SZKLANKA 'a broken glass' vs. *czubata* SZKLANKA 'a heaped glass'
d. plant/food e.g., *kawa* 'coffee', *herbata* 'tea'
   doniczkowa KAWA 'potted coffee' vs. *gorąca* KAWA 'hot coffee'
e. plant/fruit e.g., *pomidor* 'tomato', *fasola* 'bean'
   posadzony POMIDOR 'a planted tomato' vs. *umyty* POMIDOR 'a washed tomato'
f. institution/performance e.g., *balet* 'ballet', *teatr* 'theater'
   moskiewski BALET 'Moscow ballet' vs. *jednoaktowy* BALET 'one-act ballet'
g. activity/result of this activity e.g., *dyktando* 'a spelling test'
   dziesięciominutowe DYKTANDO 'a ten-minute spelling test' vs. *bezbłędne* DYKTANDO 'an error free spelling test'
h. organization/building e.g., szkoła 'school'
   wyremontowana SZKOŁA 'a renovated school' vs. *dobra* SZKOŁA 'a good school'
i. instrument/activity e.g. *szachy* 'chess'
   drewniane SZACHY 'wooden chess' vs. *szybkie* SZACHY 'a quick game of chess'

Another important feature of polysemy by metonymy is zeugmaticity[3], also referred to as co-predication (see Dölling 2020; Viebahn 2020; Ortega-Andrés

[3] Zeugma is understood as the ability to use a single word in the same syntactic position under two different senses as in *On his trip, John* ***caught*** *three trout and a cold.* However, it is noteworthy that one may find a different (even opposite) use of this term (e.g., see Cruse 1986; where 'zeugma' is understood as not allowing for the simultaneous use of the same lexical unit in two senses without bringing oddity).

and Vicente 2019; Vicente 2021). As stated in Vicente (2021: 348), 'co-predication is a strange phenomenon where a single NP apparently has more than one denotation, given that the predicates that modify said NP have mutually inconsistent selectional preferences.' Several syntactic constructions can be used to generate co-predication e.g., relative clauses, attributive adjectives or coordination of verbs or VPs. For example, in (4), the adjective 'heavy' selects for some physical object and the adjective 'interesting' applies to some abstract content.

(4) The book is heavy and interesting (Vicente 2021: 348)

Examples of zeugmatic uses of metonymic words are shown for Polish in (5).

(5) a. object/activity
OBIAD 'dinner' (*smaczny* 'tasty' vs. *rodzinny* 'family')
Zjadł smaczny rodzinny obiad.
'He had a tasty family dinner.'
b. container/unit of measure
ŁYŻECZKA 'tablespoon' (*srebrna* 'silver' vs. *czubata* 'heaping')
Wsypał czubatą łyżeczkę cukru pudru i ją oblizał.
'He poured in a heaping teaspoon of ice sugar and licked it off.'
c. tree/wood
SOSNA 'pine' (*rozłożysta* 'branchy' vs. *sękata* 'gnarled')
Cały jego dom jest obłożony lokalnie rosnącą sosną.
'His entire house is laid in locally growing pine.'
d. animal/meat
INDYK 'turkey' (*gulgoczący* 'gurgling' vs. *pieczony* 'roasted')
Na święta upiekłam indyka z wolnego wybiegu i smakował lepiej niż te z chowu klatkowego.
'I roasted a free-range turkey for Christmas and it tasted better than the caged ones.'

By contrast, polysemy by metaphor is usually not regular and non-zeugmatic. It is usually defined as a poetic tool but in fact it is pervasive in everyday communication. Metaphor is often characterized in terms of conventionality (see Pouscoulous and Dulcinati, 2019). Conventional metaphors (in contrast to novel metaphors) are very familiar, highly lexicalized and productively used by language users. In this study, we focus only on highly lexicalized conventional metaphors such as the ones exemplified in (6).

(6)
a. MUCHA (*natrętna* 'an intrusive fly' vs. *elegancka* 'an elegant bow tie')
b. NARYBEK (*odłowiony* 'caught fry' vs. *piłkarski* 'football fry')
c. MARGINES (*lewy* 'a left margin' vs. *społeczny* 'a social underclass')
d. REKIN (*rafowy* 'a reef shark' vs. *giełdowy* 'a stock market shark')
e. GŁOWA (*łysa* 'a bald head' vs. *mądra* 'a wise head')

f. PASMO (*siwe* 'a gray streak (of hair)' vs. *górskie* 'a mountain range')
g. DZIÓB (*kaczy* 'a duck beak' vs. *drewniany* 'a ship's bow')
h. AMBONA (*kościelna* 'a pulpit in the church' vs. *leśna* 'a forest pulpit')
i. AURA (*jesienna* 'autumn weather' vs. *tajemnicza* 'mysterious aura')
j. CIOS (*śmiertelny* 'a deadly blow' vs. *życiowy* 'a life-changing blow')
k. KOCIAK (*pręgowany* 'a brindle kitten' vs. *seksowny* 'a sexy kitty')
l. BARIERA (*metalowa* 'a metal barrier' vs. *psychiczna* 'a mental barrier')
m. KREW (*pobrana* 'drawn blood' vs. *królewska* 'royal blood')
n. KROK (*długi* 'a long step' vs. *mądry* 'a wise step')
o. ORZEŁ (*matematyczny* 'a mathematical genius' vs. *dziki* 'a wild eagle')

As stated earlier in this section, Klepousniotou and Baum (2007), Klepousniotou, Titone, Romero (2008), Klepousniotou et al. (2012) provide evidence in their psycholinguistic experiments that metaphor and metonymy differ in sense remoteness with the two senses of metaphorical expressions being more remote than the two senses of metonymic expressions. In this study, we extend this line of research and we propose a wider spectrum of sense remoteness of more types of polysemous words in Polish based on our research based on computational and theoretical lexicography.

3. Methodology

There is no clear answer to the question on how to divide meanings within one lexeme or how to decide which of the regular polysemes is lexicalized. Traditional lexicography distinguishes between polysemy and homonymy but it usually does not describe word formation details and inter-relationships between two words having the same lexeme. On the other hand, it emphasizes etymology as a basis to prove two words to be homonyms. This distinction may not be a very practical one when it comes to studies on contemporary language through psycholinguistic experiments on its users who are not aware of the etymology of words they interpret (see section devoted to the fifty-fifty class of polysemy for further details).

Given the above constraints, the compromise between lexicographic and psycholinguistic perspectives needed to be found. The former perspective constitutes the foundation for the present study and thus must be thoroughly examined, while the latter may shed some new light on the issue of polysemy as a psychologically real phenomenon. In the next section, we describe the methodology of data collection and quantitative results of our classification of the material into different types of polysemy.

3.1. In search for a method

Probably, the most intuitive source for finding polysemous and homonymous words are dictionaries. Unfortunately, as easy as it seems they are constructed in such a way that only meanings of homonymous words are presented under separate entries. In the case of polysemous senses, they are usually listed under one entry. Consequently, they do not provide sufficient material for polysemy research, often listing potential words, which indeed are systemically correct, created in accordance with word-formation rules, but which are either not lexicalized or not used in natural communication in Polish. Standard dictionaries of the Polish language present material by carefully taking into account etymological information (about homonyms), but do not pay as much attention to polysemy determination.

Yet average language users are rarely aware of the origin of words and are inclined to resort to folk etymology, i.e., finding a relationship between two etymologically unrelated meanings. Considering all of the above, data collected from dictionaries may be useful but should not constitute the basic source.

Importantly, the homonymy-polysemy distinction is for us a matter of speakers' mental representations and their perception of sense relatedness. It may happen that the speaker's perception of polysemous and homonymous words is distinct from what lexicographers propose in dictionaries where on the basis of etymology facts they set up a single dictionary entry in the case of polysemy and two or more in the case of homonymy. Bearing that in mind, it is not our purpose to argue that dictionaries are unreliable source of materials for the experiments on polysemy. All we want to say is that they are not sufficient and that not all types of polysemy are included in the dictionaries. Throughout the article we want to stress the importance of dictionaries, but we also want to point out that research on polysemy should not be based solely on them. It should be accompanied with databases which are more frequently updated. Some phenomena are ephemeral and dynamic, as is for instance homonymous polysemy decay; printed dictionaries do not take such changes into account, so research using dictionaries alone should not be approached in an uncritical way.

The issues of lexical semantic change and homonymous polysemy decay (Pl. 'rozpad homonimicznego polisemu') were also tackled by Giulianelli, Del Tredici and Fernández (2020) using neural contextualized word representations with the aid of quantitative procedures proposed by Schlechtweg, Schulte im Walde and Eckmann (2018). Following Hopper et al. (1991), they suggest that word meaning is virtually always accompanied with polysemous stages in the course of time rather than shifts directly from one sense to another. They additionally stress the importance of aligning the detected semantic shifts with native speakers' interpretation (i.e., human similarity

judgements), which demonstrates the pressing necessity for resorting to frequently updated resources.

Beside dictionaries, our attempts at sourcing and classifying the material have been aimed at ready-made lists taken from the existing literature, e.g. from Apresjan (1974) or Markowski (2012) but again, they provide valuable material as a secondary source, not granting the general perspective of what polysemy looks like in real language usage.

In search for a suitable method, which would reflect the actual phenomenon of polysemy in Polish, we ultimately decided to rely on the services, tools and resources of the CLARIN-PL Language Technology Center (the Polish section of the European research infrastructure CLARIN ERIC) in collaboration with the members of the Computation Linguistics and Language Technology research group. CLARIN-PL infrastructure, among many other services, offers plWordNet (Słowosieć – Dziob, Piasecki and Rudnicka 2019), which takes into account greater number of observed meanings of one lexeme than an average dictionary of the Polish language (due to the construction of the wordnet and the need to describe each meaning with a set of predefined relations). It is nonetheless important to stress out here that it is not the purpose of dictionaries to be compiled so as to reflect thought processes. All the same, a meeting point must be found between lexicographic and psycholinguistic lines of research, which traditionally have separate aims and functions. One of the aims of this work is to show that although the two perspectives have different research thoughts, they can gain much from each other.

3.2. Polysemy from a bird's eye view: Insights from computational and theoretical lexicography

Using plWordNet as a lexicographic source for the research has a number of advantages (see Figure 2 as an illustration of the search result for *grafik* in plWordNet). As far as conducting observations of relations that may occur between pairs of words with the same lemma, a lexical-semantic database such as wordnet makes the task considerably easier than using standard dictionaries. It is possible to extract a random sample of word pairs with the same lemma from the database and thus obtain material presenting an averaged state of language. It is also possible (in further stages of research), thanks to the database format, to search the resource using various criteria. There is no explicit information on homonymy in plWordNet, but some information on word-formation relations between polysemes can be read as in a nested dictionary[4] (more information, especially on direct semantic derivation, may be added to plWordNet as a result of this research).

[4] Such a dictionary is based on common etymological nests of words.

Figure 2: Search result for *grafik* in plWordNet, represented under three separate entries as 'an artist specializing in designing graphics', 'a computer graphic designer' and 'a schedule' (screenshot from plWordNet – Dziob, Piasecki and Rudnicka, 2019)

The CLARIN-PL team can generate a list of user-predefined characteristics. With their help, we were equipped with a list of **800 randomly selected nominal pairs of senses**. The plWordNet has a number of relations and attributes that were of help while generating the lists. For example, the part of speech that was filtered out was the noun, which had at least two senses with an assigned relation between them. An additional criterion used to retrieve the aforementioned sample was that the units should be attributed with elaborated glosses. Glosses not only facilitated the identification of meanings thanks to the definitions attributed to specific senses, but also provided useful information about the register. An important feature of the randomly selected sample is that it is averaged and rich enough to bring general conclusions to the table when one considers the relations that exist in pairs of senses based on the same lemma.

During a series of online meetings held by a group consisting of members of the CLARIN-PL team specializing in computational and theoretical lexicography and specialists in psycholinguistics, we have been working on selecting these senses which are indeed used by standard language users in order to treat polysemy as a mental phenomenon. Sigman and Cecchi (2002) discuss the implications of semantic networks – such as wordnets – for the mental lexicon. Semantic networks constitute an accurate indicator of semantic relatedness based on the type of relations and the number of nodes with which two lexical units are inter-connected. Graph properties of wordnets may be significant for the apprehension of the mental representation of meaning (Spitzer 1998). In psycholinguistic studies that are conducted with the use of the priming-related paradigms accompanied with a lexical decision task, subjects are requested to assess whether a string of letters or sounds (depending on the modality of the stimuli) is an existing word or

not, decisions are made faster after a semantically related lexical item than after an unrelated one (Aujla 2021). This semantic distance (apparent in the retrieval time) is correlated with the distance in a wordnet graph. Sigman and Cecchi (2002) additionally provided evidence that a polysemous word primes the different senses linked with it. A similar line of reasoning is presented in more recent works (Vitevitch et al. 2014; Zock and Biemann 2021) where the organization of the mental lexicon is revealed in graph models (Motter et al. 2002; Bieman 2012; Baronchelli et al. 2013; Morais, Olsson and Schooler 2013; Kenett, Anaki and Faust 2014; Zortea et al. 2014; Siew et al. 2019). The graph models rest on the premise that hubs (i.e., a local number of relations – density), the location of a particular word in the lexical network as well as connectedness and relative distance to other words may be measured via semantic relations in wordnets.

In order to make our findings applicable to psycholinguistic research, we wanted the quantitative part to deal with material that is used by an average user in everyday communication. Unfamiliar or infrequent words limited to certain environments or from specialized registers could de facto blur the general picture. We are interested in everyday polysemy of nouns as it functions in the minds of language users.

That is why the first step, prior to the actual analysis of the material, was filtering out these words which are not really used. Rejection criteria included repetitions, infrequent senses, archaisms, specialized register, non-normative forms of nouns and abbreviations. This filtering was based on our knowledge and lexicographic experience of the members of our team. The frequency was measured using the Polish Corpus, PELCRA NKJP (Janus, Przepiórkowski, 2007; Pęzik 2012). To illustrate the point, we filtered out the words with at least one sense not meeting the required criteria e.g., *dzieża* 'kneading trough', *scheda* 'legacy', *gawot* 'gavotte', *c.o.* 'abbr. central heating', *zachłyst* 'choking', *konwikt* 'boarding school', *lek.* 'abbr. doctor', *zielone* 'green light', *krajka* 'selvage', to mention but a few. Consequently, the selected material contained **403 pairs of senses**, which were then meticulously analyzed and annotated with an appropriate label (i.e., homonymy or a specific type of polysemy). The annotation process was continually accompanied with references to the relevant literature (Apresjan 1974; Klepousniotou and Baum 2007; Klepousniotou, Titone and Romero 2008; Klepousniotou et al. 2012; Markowski 2012; Falkum and Vicente 2015; Brocher, Foraker and Koenig 2016; Carston 2020; Vicente 2021). It is necessary to point out here that the selected method imposed on us the necessity to analyze exactly these senses which were randomly selected from plWordNet (which was not always intuitive, as some of them were not salient).

The annotation process was carried out by three independent annotators. At first, we worked together in a series of meetings on some of the

material in order to develop coherent guidelines (which later served as a reference point for the theoretical section on the different types of polysemy in the present work). Then each annotator clustered a third of the collected material, which was reviewed by the other two annotators and commented on in case of doubt.

Pre-determined classification included only those polysemy types that are well defined in the literature. In the case of discrepancies or doubts in our assessments or when a given pair did not fully fall into any of the types of polysemy defined in the literature, we used the so-called clustering, i.e. we assigned numbers and then we attempted to find common features that these different clusters had in common.

Ultimately, the selected sample was clustered into five general types, which emerged during the work of the group: polysemy by metonymy, polysemy by metaphor, nested polysemy, fifty-fifty and homonymy, with the proportions of each type illustrated in Figure 3.

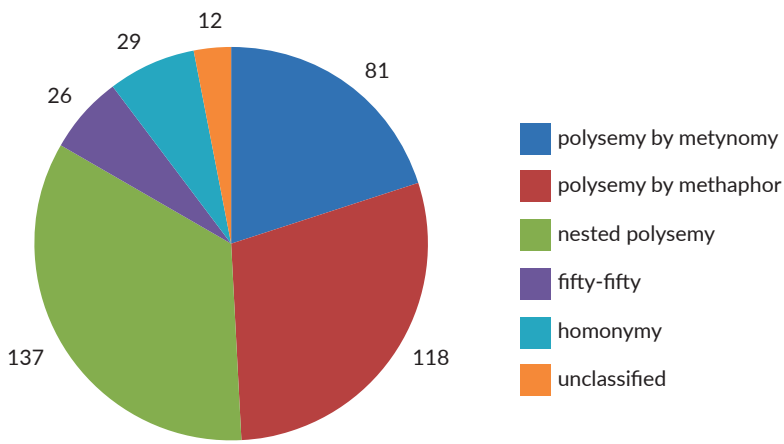

Figure 3: The occurrence of homonymy and different types of polysemy in Polish based on 403 selected pairs of nominal senses; the "unclassified" category includes problematic cases, such as *support* 'support act/warm-up act', *grzęda* 'perch', *kujawiak* 'an inhabitant of Kujawy region/type of dance' or *Jamajka* 'Jamaica/a female inhabitant of Jamaica'. The pie chart reflects different types of multisense words based on a random sample (own figure)

As shown in the above numerical data, three types of multisense words emerged as dominant: nested polysemy, polysemy by metaphor and polysemy by metonymy. The other two types – namely, fifty-fifty class and homonymy – though important from the psycholinguistic perspective, constitute

a rather peripheral phenomenon. Consequently, we decided to pursue a detailed investigation in order to propose a more fine-grained classification of polysemy organized along a spectrum of sense remoteness. To do that, the CLARIN-PL team generated additional lists of words aimed at particular types of polysemy: 180 ambiguous feminatives, 1127 polysemous lemmas with at least one sense in the domain of 'food' 2609 polysemous lemmas with at least one sense in the domain of 'human'. These additional lists were just to provide more examples so as to better illustrate a given type of polysemy, and ultimately to understand the phenomenon better – these lists did not affect the graph with the percentage distribution of each type of polysemy (percentages are based on the list of random samples only).

The paper will be continued in Klimek-Jankowska, Hwaszcz and Ławniczak (forthcoming). In the second part we will extend the spectrum of sense remoteness and present insights on different types of polysemy included in this spectrum with a special attention paid to nested polysemy.

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