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Bridging across Polysemic Senses in Bilingual Specialized Dictionaries for ESP Learners

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Abstract: Research has shown that links between polysemic senses (sense links) can and should be used to facilitate the acquisition of polysemy. However, sense links have received little attention in specialized lexicography because the concern about domain specificity has considerably reduced the number of polysemic senses that can be entered in specialized dictionaries. The descriptive shift in terminology research and the implications of cognitive semantics for learner's dictionaries have paved the way for dealing with sense links further in specialized dictionaries for learners (SDLs). Using computing-related lexical items as examples, this article proposes three guidelines for treating polysemy in SDLs with the aim of entering polysemic senses that do not belong to a given subject field while maintaining the focus on the subject field. It also presents four models for describing sense links in bilingual specialized dictionaries for ESP learners (BSDLs). Depending on the magnitude of overlap between the target language (TL) equivalents of the source and target senses as well as the effects of other factors, sense links are represented by ordering senses logically, appending the source sense[1], combining logical ordering with a short explanation, or providing both the source sense and a short explanation. The guidelines and models can help address the major situations that lexicographers encounter when describing sense links in BSDLs and hopefully contribute to learners' acquisition of technical senses.

Keywords: SENSE LINKS, ACQUISITION OF TECHNICAL SENSES, BILINGUAL SPECIALIZED DICTIONARIES FOR LEARNERS, DOMAIN SPECIFICITY, GUIDELINES, MODELS, SEMANTIC DISTANCE, OVERLAP OF TARGET LANGUAGE EQUIVALENTS

Opsomming: Die oorbrugging van polisemiese betekenisse in tweetalige gespesialiseerde woordeboeke vir ESD-leerders. Navorsing het getoon dat polisemiese betekenisse (betekenisskakels) gebruik kan en moet word om die aanleer van polisemie te vergemaklik. Betekenisskakels het egter min aandag in gespesialiseerde leksikografie ontvang aangesien die fokus op domeinspesifiekheid die aantal polisemiese betekenisse wat in gespesialiseerde woordeboeke opgeneem kan word, aansienlik verminder het. Die deskriptiewe skuif in terminologienavorsing en die implikasies wat die kognitiewe semantiek vir aanleerderwoordeboeke inhou, het die weg gebaan vir die verdere hantering van betekenisskakels in gespesialiseerde woordeboeke vir leerders (GWL's). Deur rekenaarverwante leksikale items as voorbeelde te gebruik, word

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daar in hierdie artikel drie riglyne vir die hantering van polisemie in GWL's voorgestel met die doel om polisemiese betekenisse wat nie tot 'n gegewe vakgebied behoort nie, op te neem, terwyl die fokus steeds op die vakgebied bly. Vier modelle vir die beskrywing van betekenisskakels in tweetalige gespesialiseerde woordeboeke vir ESD-leerders (TGWL's) word ook voorgestel. Afhangende van die omvang van die oorvleueling tussen die doeltaalekwivalente (DT-ekwivalente) van die bron- en doelbetekenisse sowel as die gevolge van ander faktore, word die betekenisskakels voorgestel deur die betekenisse logies te orden, deur die bronbetekenis[1] by te voeg, deur logiese ordening met 'n kort verklaring te kombineer, of deur die bronbetekenis en 'n kort verklaring te verskaf. Die riglyne en modelle kan help om die vernaamste situasies wat leksikograwe teëkom wanneer hulle betekenisskakels in tweetalige gespesialiseerde woordeboeke vir ESD-leerders beskryf, te hanteer, en hopelik bydra tot leerders se aanleer van tegniese betekenisse.

Sleutelwoorde: BETEKENISSKAKELS, AANLEER VAN TEGNIESE BETEKENISSE, TWEETALIGE GESPESIALISEERDE AANLEERDERWOORDEBOEKE, DOMEINSPESIFIEKHEID, RIGLYNE, MODELLE, SEMANTIESE AFSTAND, OORVLEUELING VAN DOELTAALEKWIVALENTE

1. Introduction

Polysemy has been recognized as a significant problem in learning vocabulary in both General English (GE) and English for Specific Purposes (ESP) (Mićović and Beko 2022: 125). It is acknowledged that "there is a great deal more involved in knowing a word in an L2 than being able to match it with an L2 synonym or provide an L1 translation equivalent" (Read 2004: 211). One suggestion for increasing the depth of EFL learners' vocabulary knowledge is to acquire the multiple meanings of polysemous lexical items (Richards 1976; Nation 1990; Li and Kirby 2015). However, achieving this goal is not easy.

Compared to native speakers' use of polysemy, EFL learners' difficulty in acquiring polysemy can partly be attributed to their limited ability to deduce peripheral or infrequent senses from central or frequent ones (Miao 2015: 221). Therefore, teachers are recommended to "help learners to get accustomed to the idea that different uses of words may have a shared underlying meaning" (Nation 2013: 306) and "to see how the technical sense of the words relates to the core meaning of the word" (Chung and Nation 2003: 113). Empirical studies have shown that awareness of the central or core senses of polysemes contributes to the acquisition of the peripheral or non-core senses (Verspoor and Lowie 2003; Maby 2016). Cognitive linguistics provides further insights into this issue. Various mechanisms such as metaphor, metonymy, specialization, generalization, profile shift and image-schema transformations have been proposed to explain how polysemic senses are interrelated (Lakoff 1987; Radden and Kövecses 1999; Taylor 2003; Tyler and Evans 2004; Gries 2015: 474). These insights can be used to train EFL learners to see the connections between polysemic senses. In fact, some researchers have experimented with the cognitive semantic view of polysemy in EFL settings, and the majority of these studies have confirmed that explaining the motivations for semantic extensions promotes L2 learners' acquisition of polysemes (Csábi 2004; Morimoto and Loewen 2007; Beréndi et al. 2008;

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Tyler et al. 2011; and Zhao et al. 2018).

However, specialized lexicography has shown limited interest in these theoretical insights and empirical findings. There have been few discussions about the links between polysemic senses in specialized dictionaries for learners (SDLs). The first noteworthy study is Van der Meer (2010: 139), who suggested that definitions can be written "using a vocabulary (e.g. collocations) that at least strongly hints at the field of discourse from which the metaphor was originally taken" for technical senses that are extended from basic ones through transparent metaphors. Van der Meer also pointed out that "the more farfetched fanciful or complicated cases will have to remain unexplained" to avoid "changing the dictionary's ESP character" (ibid). L'Homme (2020a) is another study of particular relevance. While describing how to make meaning distinctions by presenting lexical functions, labeling argument structures or relating to semantic frames, the researcher admitted that it is difficult to account for connections between remotely linked senses using lexicographical devices such as hierarchical alphanumeric systems and cohesiveness between definitions, as terminologists usually deal with domain-specific meanings only. As revealed by both studies, links between senses remain to be further explored, and the focus on domain-specificity seems to hinder efforts to capitalize on these links more extensively.

On the one hand, it is important for ESP students to learn technical senses because they are part of key code words essential for their communication within academic discourse communities (Swales 1990). On the other hand, technical senses are difficult to learn as they are usually more peripheral and less frequent. Considering the importance and difficulty of learning technical senses, it is necessary to help ESP learners of technical vocabulary understand how a technical sense of a polyseme is extended from its other senses, regardless of whether these senses are domain-specific. This article aims to explore how bilingual specialized dictionaries for ESP learners (BSDLs) can deal with the restrictions arising from domain specificity and exploit various sense links in a user-friendly way. The rest of the article is structured as follows. Section 2 will describe the impact of the paradigm shift from Prescriptive Terminology to Descriptive Terminology on the view of polysemy. Section 3 will review the practice and proposals regarding the representation of sense links in general language dictionaries (GDs). Section 4 will explain why SDLs need to focus on one single subject field and how it is still possible to represent links between polysemic senses. Section 5 will describe the different ways of representing sense links in BSDLs, using various lexicographical devices and taking into account the semantic distance between the involved senses in a bilingual setting. The last section will summarize the research findings and limitations.

2. The influence of Descriptive Terminology on polysemy

Traditional Terminology (as a discipline) considers language in terms of its naming capacity only (Temmerman 1997: 54). It is the vocabulary that assumes the role of naming specialized concepts. However, the vocabulary used in specialized

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communication, i.e. terminology, does not seem to be very different from that used in general situations (Cabré 1999: 81), which is often described as too ambiguous. In order to promote effective and efficient communication, terminology must be standardized before it is suitable for naming concepts univocally. For instance, deliberate, albeit not always successful, attempts have been made to reduce polysemy, a common language phenomenon where one term designates more than one concept. There is now a growing consensus that "standardisation is only one aspect of what should be the concern of the theory of Terminology" (Temmerman 2000: 220). Some basic tenets of Traditional Terminology have been challenged by a descriptive paradigm. We will discuss two aspects of this paradigm that are most relevant to the present study.

2.1 Polysemy and the semasiological approach to Terminology

According to Wüster (1991: 1), Terminology begins with concepts. Only after concepts are clearly delineated within a conceptual system will terms be assigned as ideal linguistic labels. Prioritizing concepts in terminology work entitles terminologists to select or create labels for concepts, leading to an overwhelming dominance of nouns over other parts of speech in terminological resources (Rey 1979; Sager 1990: 51). Moreover, Traditional Terminology holds that the relationship between concepts and terms can be manipulated through standardization to achieve univocity. For example, when concepts across domains are designated by one term, polysemy is treated as homonymy despite the perceptible relatedness between the meanings. When concepts within a single domain share one label, polysemy is eliminated by creating new names to distinguish the concepts.

However, the onomasiological approach is rarely adopted in the practice of terminography (Sager 1990: 56; Cabré 1999: 108; Temmerman 2000: 230; L'Homme 2005: 1117) because "quite obviously, the concept is not accessible unless via the designations" and "it is the designation that serves as a starting point" (Costa 2013: 32). The alternative is the semasiological approach, which allows terminologists to identify terms in texts and work towards their meanings or the concepts they designate. It is difficult for terminologists to ignore polysemy, where one term designates several concepts. The semasiological approach also extends terms to other word classes (see L'Homme 1998). Corpus data confirm that nouns are not the only category of designations for concepts. Verbs and adjectives are more typical linguistic expressions of ACTIVITY and ATTRIBUTE, laying the foundation for defining the corresponding noun forms (L'Homme 2015: 79). Therefore, it is theoretically possible to study polysemy associated with two or more parts of speech. In addition, terms, according to the new approach, do not seem to be very different from words when considered from the formal or semantic point of view (Cabré 1999: 81). Theories of lexical semantics are also applied to researching polysemy in Terminology. In particular, insights about regular polysemy, alterations, and micro senses are

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used to identify polysemy in Terminology by making finer-grained distinctions between the multiple meanings of a term within a single field (L'Homme 2020a; L'Homme 2024).

2.2 Polysemy and the diachronic perspective on Terminology

Traditional Terminology does not study language development and language evolution. The logic behind this principle of synchronicity is that "the present meanings of terms are important", and, in order to delineate the meanings of terms, "the system of concepts is what matters in language" (Felber 1984: 98). This is not difficult to understand since "normally, when one studies terms, it is useful to view them as highly 'fixed' entities, marking clearly delineated conceptual spaces within a given domain of expertise" (Meyer and Mackintosh 2000: 111). The synchronic perspective, however, has further marginalized polysemy in Terminology.

According to Blank (2003: 268), "the best-known type of polysemy is metaphoric polysemy which derives in most cases from metaphor as a diachronic process". After all, "understanding is never a static situation but a constantly changing process in time …", so "there is a constant development in what a term can be used to refer to" (Temmerman 2000: 149-150). Therefore, it would be impossible to do justice to polysemy in Terminology without considering the diachronic dimension of the specialized language. Thanks to the descriptive shift in Terminology, researchers have come to realize that it is wishful thinking to try to fix concepts. Meyer and Mackintosh (2000) provide a textbook example of this dynamic process. Their case study of "virtual" illustrates how a general language sense (i.e. almost) evolved into a technical sense in computing (as in "virtual reality") through terminologization, which in turn was diluted to give rise to a new general language sense (as in "virtual cheesecake") or a new sense loosely related to computing (as in "virtual tours") by means of de-terminologization. It is interesting to note that the derived technical sense (as in "virtual reality"), when used in economics, was re-terminologized into a new technical sense (as in "virtual currency"). Temmerman (2000: 141, 143) traced the history of cloning, revealing that the meaning extensions of "clone" are a diachronic process of polysemization influenced by critical advancements in biology. She also investigated the metaphorical models (e.g. DNA IS A LANGUAGE) behind the process whereby a word (e.g. translate) is borrowed from one domain (e.g. language) by another domain (e.g. biology), resulting in a new sense (e.g. "decipher genetic instructions for making protein") (ibid: 184).

3. Representation of sense links in general language dictionaries

In the 19th century, lexicography, as well as etymology and semantics, "were engaged in discovering the connections between the meanings of polysemous words" (Nerlich and Clarke 1997: 351). The connection between polysemic senses

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is still a central topic in the treatment of polysemy in dictionaries. Lexicographers have been trying to represent sense links in the following two ways: (1) by laying out senses to reflect the semantic structure; and (2) by explicating how one polysemic sense extends to another. Depending on whether the lexicographical representation is informed by cognitive linguistics (CL), we will identify two periods, namely the traditional period and the CL-informed period, and review what lexicographers have achieved in the two periods respectively.

3.1 Traditional representation of sense links

The first use of the term *polysemous* in a linguistic sense can be attributed to the literary theorist August Wilhelm Schlegel (Nerlich and Clarke 1997: 351). Schlegel (1832: 42, quoted in Nerlich and Clarke 1997: 356) wrote that, when dealing with polysemous terms, lexicographers should observe the affinity between meanings and retrace the gradual and graded pathway that leads from one to the other. The author pointed out that "sometimes a single series is not enough: we have to come back several times to the common stem, so as to be able to retrace the divergent ramifications" (ibid). The processes of semantic development were referred to by Darmesteter (1886: 76) as radiation (i.e. a word accumulates meanings around a core) or concatenation (i.e. a word develops a polysemic chain of meanings). According to him, radiation and concatenation are generally mixed and combined, resulting in far more complex forms.

Lexicographers explore how the structural complexity of polysemy can be represented in dictionaries. For instance, Mel'čuk and Polguère (1995: 162-171) developed methodologies to order senses and indicate semantic distances between them in their dictionary project. Specifically, polysemic senses are ordered by considering factors such as the inclusion relationship between senses, their semantic proximity to the basic sense, the nature and regularity of semantic extension, and the underlying component for metaphorical extension. In addition, the semantic distances between senses are classified as large, medium or small according to the common part of their definitions as well as the semantic distinction between them. Finally, senses are hierarchically arranged into three layers, labelled with Roman numerals, Arabic numerals and lowercase letters to indicate the semantic distances across layers or within each layer. Mel'čuk and Polguère (1995: 157-159) hold that links between senses can be direct or indirect, depending on whether they are connected by a semantic bridge (i.e. an explicit or implicit semantic component shared between definitions). In the case of metaphorical extensions, a component is introduced in the definition of a derived sense to serve as a semantic bridge with the source sense (ibid: 161).

Arguing against treating sense links merely as an appendage to definitions, Barque (2008: 84-85) dedicated a separate module to represent sense links in a dictionary project. Thanks to this new approach, the researcher refined Martin (1979)'s typology of sense links and characterized them more systematically. The inclusion relationship between senses is analyzed in terms of the central

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or peripheral status of the shared semantic component in the definitions. The actantial structure and referential nature (abstract or concrete) of polysemic senses are compared to determine whether and how they change due to meaning extension. Additionally, the rhetorical effect (contiguity or analogy) or the lack thereof is also examined in modeling sense links (Barque 2008: 117). By considering the syntactic, semantic, and rhetorical dimensions, the researcher identified four types of sense links: restriction, extension, metonymy and metaphor. Each category is further divided: restriction is sorted into specialization and euphemism, and extension into generalization and exaggeration. Metonymy is characterized as strong or weak, and metaphor as sensory or structural (ibid: 127).

3.2 CL-informed representation of sense links

According to Geeraerts (2001: 7), cognitive semantics has added a number of new insights to the description of sense links. Prototype Theory characterizes polysemy as follows: one sense may directly or indirectly form the basis of others, carrying more structural weight and functioning as the prototype. Peripheral meanings are derived from, and clustered around the prototypical meaning. All meanings of polysemous lexical items are structured into radial sets and interrelated through family resemblance (Lewandowska-Tomaszczyk 2007: 148). Cognitive semantics has identified various types of motivational links between polysemic senses: metaphor, metonymy, specialization, generalization, profile shift, and image-schema transformations (Radden and Kövecses 1999, Taylor 2003, Tyler and Evans 2004, Gries 2015: 474). These links, grounded in experience, cannot be adequately explained without drawing on language users' experience of their physical, social and cultural surroundings (Boers and Lindstromberg 2008, 2009).

The cognitive linguistic view of polysemy has sparked interest in the pedagogical value of logical sense ordering in learner's dictionaries (Van der Meer 2004, Wojciechowska 2012, Ostermann 2015: 321, Xu and Lou 2015: 224, etc.). Logical sense ordering arranges senses at two levels (i.e. a central or basic level for core senses and a subordinate level for sub-senses) (Moerdijk 2003: 286) and nests subsenses under their corresponding core senses. Due to its linear layout, logical sense ordering cannot fully capture the multidimensional structure of polysemy. To solve the linearization issue identified by Geeraerts (1990: 198), Lu and Wei (2019) proposed a graphic representation of the polysemic structure as a supplement to the linear layout of senses. Instead of a radial network, Lu et al. (2020) presented a left-to-right mind map, where all senses are reduced to short definitions and expressed as nodes, with the prototypical sense placed at the leftmost part and extending rightward to peripheral senses.

Another weakness of logical sense ordering is its failure to explain the extension of one sense to another. To address this problem, some researchers suggested using core definitions to "cover in a general way all derived subsense definitions" (Van der Meer 2000; Smirnova 2016). Halas (2016: 136) proposed

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incorporating the dominant semantic component shared with the superordinate sense in the definition of a sub-sense. While these defining strategies sometimes successfully clarify links between core senses and sub-senses, they encounter difficulties when metaphor is involved. An alternative solution is to label senses as "metaphoric extensions" (Smirnova 2016) or use phrases like "resemble" (Halas 2016: 137), "as if" (Van der Meer 2000: 426), and "metaphorized into" (Zhao 2003: 186) to introduce metaphor in definitions. However, this kind of dictionarese may not be clear enough for users to understand the mechanism. Full-sentence definitions (Hanks 1987: 119; Rundell 2006: 324; Atkins and Rundell 2008: 441) offer a remedy to explain sense links (Lu and Wei 2019; Lu et al. 2020). They consist of two parts: the left-hand part introduces the headword, and the right-hand part relates two vertically adjacent senses in the hierarchy. If a sense link is metonymic, the short definition of the superordinate sense is treated as an adverbial or modifier and attached to the subordinate sense. In the case of metaphoric links, a *like* phrase or an *as-if* clause is used to relate the two senses. Occasionally, life experience is invoked to clarify an obscure relation involving conceptual metaphor.

4. Domain specificity and polysemy in specialized dictionaries for learners

Polysemy is notably less common in SDLs than in GDs. For instance, Bergenholtz and Kaufmann (1997) found that out of 2,500 dictionary articles in a dictionary of biotechnology, only three have more than one meaning. Even when the same word is entered in both types of dictionaries, the ratio of meaning to lexical items is still lower in SDLs than in GDs (see Cooper 2005; L'Homme 2020a). This difference can be partly explained by SDLs' usual preference for polysemy that is specific to a particular subject field only and often limited in number compared with other types of polysemy. While it is reasonable for SDLs to focus on a single subject field, it is also possible to reconcile domain specificity with polysemy that spans multiple subject fields or includes both specialized and general meanings.

4.1 Reasons for SDLs' focus on a single field

According to Bergenholtz and Tarp (1995: 59), a specialized dictionary can cover either an entire subject field, several subject fields, or one or more sub-fields, referred to as single-field, multi-field and sub-field dictionaries, respectively. There has been some debate among lexicographers regarding the disciplinary coverage of SDLs. Zhang (2009: 32), for example, believes that SDLs at the initial stages should not be too narrow in their coverage of the subject field. Instead, comprehensive or multidisciplinary dictionaries should be compiled first, and then gradually move towards single-field dictionaries. In contrast, Gouws (2010: 66) argues against covering multiple fields in one SDL, stating it

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"may be confusing to the users, especially if each central list text has its own front and back matter texts, constituting a range of secondary frame structures". We also argue against covering multiple fields in SDLs.

Similar to Gouws (2010: 66), our first reason is also concerned with the lexicographer's perspective. Bergenholtz and Tarp (1995: 59) pointed out that multi-field dictionaries are not recommended. They detailed the difficulties that the coverage of multiple subject fields might cause in the compilation process: it is hard to ensure a uniform treatment of the subject fields. For example, lemma selection for a multi-field dictionary is often based on the most frequently used terms or the basic vocabulary of the subject fields. Despite having specialized corpora for some disciplines, lexicographers still need to consult a wide range of experts for lemma selection. Unfortunately, "experts may turn out to differ widely as to what should be considered important or central in their respective subject fields", resulting in "different criteria being employed for practical lemma selection in the same dictionary" (ibid: 60). Another problem with dealing with multiple subject fields simultaneously is related to the treatment of encyclopedic information in SDs. Firstly, the coverage of vocabulary in multi-field dictionaries is often so massive that there is little or no space left for encyclopedic information, which is often necessary for disambiguating terms that may have different meanings across subject fields. Secondly, the preparation of encyclopedic notes requires the involvement of experts from various subject areas, leading to coordination challenges similar to lemma selection. Finally, it is difficult to offer an encyclopedic section or subject-field introduction that provides an overall view of the individual subject areas. Although considered important for the pedagogical dimension of specialized dictionaries (Tarp 2005) and beneficial to layman users in particular (Bergenholtz and Nielsen 2006: 290), a subject-field component covering all subject fields would be too voluminous and complex to be implemented in compilation.

Our second piece of evidence comes from Terminology and relates to the facilitation of learners' acquisition of specialized knowledge of concepts. Terminologists have found that many concepts can be classified in more than one way because there are multiple characteristics that can be used to distinguish between the concepts. This was referred to as multidimensionality by Bowker (1993) in Terminology. This term has since been expanded to mean the "phenomenon where the same concept can be conceptualized from different perspectives" (L'Homme 2020b: 89). Subject fields provide important perspectives that can influence how concepts are related to other concepts. For example, in Engineering, the most prominent conceptual relations to the concept "water" are MADE_OF and AFFECTS, whereas in Geology, CAUSES and TYPE_OF are the most salient conceptual relations. Additionally, subject fields also shape the conceptual categories that a concept can be associated with. In Engineering, "water" is only linked to artificial entities or processes (PUMPING, CONCRETE, CULVERT), while in GEOLOGY it is primarily associated with natural ones (EROSION, GROUNDWATER, SEEPAGE) (León Arauz and Faber 2010). While multidi-

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mensionality can be used to enrich traditional static representations in terminological resources, it can also lead to information overload, which hinders knowledge acquisition. This can also be illustrated with the concept "water". According to León Arauz and Faber (2010), 'water' is a versatile concept involved in numerous environment-related situations. Therefore, a large number of conceptual relations will form around "water" if all its dimensions are reflected in the conceptual network. Obviously, users would not acquire meaningful knowledge if they are overwhelmed by a multitude of conceptual relations. The problem of information overload can be solved through recontextualization, such as by specifying a certain subject field. For example, when the contextual constraint of Engineering is applied (León-Araúz et al. 2013: 46), relevant relations (e.g. WATER part_of CONCRETE) will be retained while irrelevant ones (e.g. WATER affects SEEPAGE, which is more typical of Geology) will be filtered out. Recontextualization not only reduces interference from other subject fields but also increases coherence within the specified domain, thereby enhancing the effectiveness of knowledge acquisition.

4.2 Guidelines for treating polysemy in SDLs

The subject coverage of specialized dictionaries is primarily reflected in the selection of headwords. To maintain a focus on a particular subject field, only lexical items specific to the field will be considered for inclusion in the lemma list of an SDL. Since it is usually the meanings, rather than the forms, of lexical items that indicate their affinity with a subject field, the domain specificity of meanings is often used as the criterion for determining whether a word or phrase should be included. However, if the criterion of domain specificity is strictly applied, SDLs will only record polysemes consisting of meanings that are specific to a subject field, as is the case with most specialized dictionaries. This would limit SDLs' ability to utilize sense links to assist learners in acquiring specialized senses they may struggle with. To address this, we propose the following guidelines for handling polysemy in SDLs while still maintaining a focus on a subject field. We will demonstrate these guidelines using computing-related expressions.

4.2.1 The polyseme considered for inclusion in SDLs should contain at least one domain-specific meaning. This guideline establishes the minimum requirement that polysemy must meet in order to be considered in SDLs. As mentioned earlier, the domain specificity of a lemma is represented by the meaning which belongs to a specific subject field. Therefore, a polysemous expression can be included in the lemma list as long as it carries a meaning that is specific to the subject field that defines the disciplinary boundary of an SDL. The requirement for domain specificity should not obscure the fact that the meanings of a polysemous word are often not limited to a single subject field. The composition of polysemic meanings in SDLs can be summarized in the following three

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situations: (1) Polysemous terms are exclusively domain-specific, comprising meanings that are unique to a particular subject field (hereafter referred to as domain-specific meanings). For instance, "write-protect" carries two domain-specific meanings: "protect (a disk) from accidental writing or erasure" and "able to stop data being written to or erased from a disk". (2) Polysemes have specialized meanings only, with some being domain-specific and others pertaining to diverse subject fields. For example, the two meanings of "working memory" are specific to the subjects of psychology and computing respectively. (3) Certain polysemic meanings are specific to a particular domain, while others are used in language for general purposes. A typical example is "menu", for which the computing meaning is a metaphorical extension of its general language use. Intra-domain polysemy and inter-domain polysemy, as defined by Meyer and Mackintosh (2000), will be used to designate the first and second types of polysemy respectively. The third type, where the meaning range of polysemy extends beyond specialized domains, will be referred to as extra-domain polysemy.

4.2.2 At least one domain-specific meaning should be addressed as the learning target. This guideline emphasizes the pedagogical considerations when incorporating polysemy in SDLs. When we classify polysemy into three categories, we take a synchronic perspective. However, the three types of polysemy can be understood as resulting from a diachronic process involving semantic extensions between pairs of meanings. The composition of polysemy in SDLs shows that there are three types of meanings: domain-specific meanings, meanings related to other subject fields, and meanings used in language for general purposes. Theoretically, each type of meaning can derive from, and extend to, other types of meanings. Since our goal is to enhance learners' acquisition of domain-specific senses, we are primarily interested in links leading to a domain-specific sense. The domain-specific sense that is to be learned will hereafter be referred to as the target sense, as opposed to the source sense from which it derives. This does not rule out the possibility that a domain-specific sense functioning as the source sense may extend to another domain-specific sense and facilitate its learning. Therefore, the three processes of polysemization described in Section 2.2 will be treated differently: terminologization (as in "menu") will be fully considered in the treatment of polysemy in SDLs but determinologization (such as the computing meaning of "real time" being extended to describe processes like reporting and decision-making) will not be included in meaning descriptions. Re-terminologization will only be taken into account when it results in domain-specific meanings. For instance, the link between the two senses of "working memory" will be considered in SDLs because the psychological sense extends to the computing sense, not the other way around.

4.2.3 The target sense should be explained in relation to the source sense(s) in the meaning description. This guideline clarifies the position of a target sense

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relative to its source senses in SDL's representation of polysemy. Semantic extension involves at least two senses: a source sense and a target sense. It is important to have an operational description of both terms. According to L'Homme and Polguère (2008), the perception of semantic extension is usually connected to a diachronic reality. They argue that "it is necessary to decide whether one bases oneself on the true etymology, as one can retrace it in a historical dictionary, or on the intuitive perception of the ordinary speaker" (ibid). We will adopt the second approach: two senses will be treated as the source sense and the target sense, respectively, as long as the meaning description of the latter can build on the former, regardless of the chronological sequence of their earliest occurrences as documented in a historical dictionary. For example, citations in *The Oxford English Dictionary* (Simpson and Weiner 1989) show that the intransitive use of "reboot" is younger (more recent) than the transitive use. However, the former is still considered the source sense and the latter the target sense because the transitive use specifies the agent by building on the argument structure of the intransitive use and the arrangement aligns with ordinary people's intuition that a syntactically simpler meaning appears first and develops into a more complex one later. The target and source senses are not of equal importance in the meaning description: the latter is a means to an end, i.e. it is used to help learners acquire the former. Therefore, they are treated differently at the microstructural level: the target sense always receives a definition in SDLs. In contrast, the source sense is usually not defined unless it is specific to the same domain. In terms of the meaning description of a given target sense, the source sense is either used as part of the gloss for the definition of the target sense (e.g., placed within brackets to make explicit the sense link) or incorporated into its definition (e.g., embedding the meaning of an inchoative verb in that of a causative verb).

5. Representation of sense links in bilingual specialized dictionaries for ESP learners

Building sense links involves bridging semantic gaps between polysemic senses. Therefore, the magnitude of the semantic gap, or the semantic distance, must be assessed to determine how sense links are represented in BSDLs. There have been attempts to characterize the semantic distance between polysemic senses. For instance, Mel'čuk and Polguère (1995: 162-171) categorize it as large, medium and small, depending on the extent of the semantic intersection and the regularity of the semantic distinction. L'Homme (2020b: 107) suggests that the scale of semantic distance accounts for three forms of polysemy: long-distance polysemy, which occurs between a basic meaning and a metaphorical extension; short-distance polysemy, where one or a few semantic components are shared by the lexical units; and regular polysemy, as originally defined by Apresjan (1974: 16). These discussions provide useful insights, but they only address monolingual settings. When representing sense links in BSDLs, the linguistic dimension must

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also be considered because the perceived closeness between polysemic senses in a bilingual dictionary may be influenced by the degree of overlap between their target language (TL) equivalents.

In what follows, we will illustrate the lexicographical representation of sense links using computing-related polysemy extracted from *The English–Chinese Dictionary (Unabridged)* (Lu 2007). Thanks to the subject labels for computer science, we were able to retrieve all polysemous items with at least one computing-specific sense. When phrasing definitions, we also drew upon specialized dictionaries such as the *Oxford Dictionary of Computing for Leaners of English* (Pyne and Tuck 1996) and the *Dictionnaire fondamental de l'informatique et de l'internet* (L'Homme 2024). By surveying and adapting the extracted data, we will attempt to represent sense links in BSDLs. The proposed model takes into account factors such as the semantic intersection of the polysemic senses, the regularity of their semantic distinction, the mechanism for semantic extension, and the overlap between their Chinese equivalents. Since we are only interested in information categories that facilitate the explanation of sense links, we will leave out pronunciations but retain parts of speech, subject labels, and TL equivalents. Illustrative sentences will be omitted to highlight the layout of the model, although they are particularly useful in describing the meaning of predicative senses. Moreover, to make the overlap between the source and target senses identifiable and accessible, we will italicize the shared parts of their Chinese equivalents. According to the lexicographical devices needed to bring out the connections between senses, the models are presented using one of the following four means: ordering senses logically, appending the source sense, combining logical ordering with short explanation, or providing the source sense and a short explanation. We will also translate the right-core semantic comment of each entry into English in a literal (and perhaps unnatural) way to help non-Chinese readers of this paper understand how the Chinese equivalents overlap and how two senses in Chinese are linked (Please note that the English translation is not intended as part of the BSDL models).

5.1 Lexicographical representation by ordering senses logically

When the senses forming regular polysemy are all domain-specific and their TL equivalents clearly overlap, links between them can be represented by placing the source sense before the target sense.

(1) GIF n.【计】<computing>
1. *图形交换格式* <*graphic interchange format*>
2. *图形交换格式*文件 <a file in *graphic interchange format*>

(1) is a typical case of regular polysemy since the "format to file" pattern of extension can be observed in other polysemous words such as PDF and JPEG. As shown by the Chinese equivalents, the source sense "*图形交换格式*" is in-

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cluded in the target sense "*图形交换格式文件*". The former denotes a file format whereas the latter refers to the file in this format. Learners should be able to understand the link between the two senses by comparing their Chinese equivalents. Therefore, there is no need for further lexicographical devices.

(2) boot up【计】<computing>
1. vi.（*电脑*、*系统*）*启动* <(*computer*, *system*) *start*>
2. vt.（用户）*启动*（*电脑*、*系统*） <(user) *start* (*computer*, *system*)>

(2) illustrates another type of regular polysemy, which is also called inchoative/causative alternation (L'Homme 2020b: 108). In the source sense, the phrasal verb "boot up" is used intransitively, meaning that the computer or system starts by itself. In the target sense, the same expression is used transitively, where the user is the subject who causes the computer or system to start. Although they differ in the argument structure, they are clearly derived from the same underlying event of rebooting, with one realizing part of the event structure linguistically and the other encoding the whole. Therefore, placing the intransitive sense before the transitive one should suffice to account for the sense link.

(3) telnet 【计】<computing>
1. n. *远程登录服务* <*remote log-in service*>
2. vi. (访客、用户) 使用*远程登录服务* <(visitor, user) use *remote log-in service*>

(3) results from a process of word-formation traditionally known as conversion. This mode of word-formation is now recategorized by some cognitive semanticists as a process whereby a salient participant is singled out as the "metonymic focus" to designate the whole event (Dirven 1999: 280, Dirven and Verspoor 2004: 64). The new perspective is reflected by the close link between the Chinese equivalents of the two senses, where "telnet" is used to designate the event of using "telnet".

5.2 Lexicographical representation by appending the source sense

When the source sense is not domain-specific and the TL equivalents of the headword in the source and target senses clearly overlap, links between them can be represented by appending the source sense. The added sense will be marked with an arrow pointing to the target sense and placed in the brackets following the target sense.

(4) mouse n. 【计】<computing> *鼠标* [←*鼠*；*老鼠*] <*mouse* pointer [←rat, *mouse*]>

In (4), the source sense "*鼠*; *老鼠*" is added to help learners understand why a word often referring to a small rodent can be used in computing to mean an

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input device especially for a computer. The source sense is terminologized into the target sense through a metaphor that is based on similarity in shape: a classic computer mouse has a cable extending from one end of its grip portion, resembling a mouse dragging its tail behind it. Even if the shape of a mouse has evolved in response to new technology (e.g. a wireless mouse does not have a cable), the shape of the grip portion remains largely the same. Therefore, italicizing the shared character "鼠" contributes to learners' understanding of the sense link.

(5) validation n.【计】<computing> (计算机用户对数据、文件的) *确认* [←批准；*确认*] <(user's) *confirmation* (of data, file) [←approval, *confirmation*]>

(5) is another example of extra-domain polysemy. The source sense is translated into two Chinese words (i.e. 批准 and 确认), which are combined to cover the meaning. Of the two words, 确认 is used as the Chinese equivalent of the technical sense after it is modified by a phrase specifying the possible agent and patient of the action denoted by the headword "validation". A comparison of the equivalents reveals that the technical sense is actually a specialization of the general sense or a microsense (See Cruse 1995).

5.3 Lexicographical representation by logical ordering plus short explanation

When the source sense and target sense(s) are both domain-specific and there is little or no overlap between their TL equivalents, it is not sufficient to place the source sense before the target sense only. A short explanation placed in the brackets following the target sense is also needed to make explicit its link with the source sense.

(6) bit n.【计】<computing>
1. *二进制位*，二进制数字 <***binary digit***, binary number>
2. 比特（度量信息的最小单位）[比特（bit的音译）用于度量以*二进制位*编码的信息量] <pi-tê (the smallest unit of information) [pi-tê (the transliteration of bit) is used to measure the amount of information encoded in ***binary digits***]>

(6) is a case of regular polysemy where one sense denotes a concrete element while the other refers to an abstract measure. However, this element-to-measure link between the two senses of the word "bit" is not obvious to learners because there is no overlap between the equivalents "二进制位，二进制数字" and "比特". As shown by the Chinese translations, the TL equivalents of the source sense are meaning-based whereas that of the target sense is form-based (i.e. transliteration). It is, therefore, necessary to add a short explanation to make explicit the link between the two senses.

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(7) initialize vt. 【计】<computing>
1. *预置* <*prepare*>
2. 格式化 (磁盘) [格式化磁盘就是*预置*磁盘，以存储和读取数据] <format (computer disk) [to format a computer disk is *preparing* it for storing and reading data]>

(7) falls into the category of intra-domain polysemy. Of the two computing-specific senses, the first can be defined as "to prepare a piece of computer equipment or software for use" and the second as "to prepare a computer disk for use so that it can store and read data". The semantic intersection between the English definitions shows that the target sense is a specialized case of the source sense. However, the semantic connection is "lost" in translation due to the lack of overlap between their Chinese equivalents. A short gloss, therefore, is provided to restore the sense link.

5.4 Lexicographical representation by providing the source sense and a short explanation

When the source sense is not domain-specific and the overlap between the TL equivalents of the headword in the source and target senses is not sufficient to explain the links between them, a short explanation in addition to the source sense should be provided to make explicit its link with the target sense.

(8) toolbox n.【计】<computing> *工具箱* [←（由木头、塑料或金属制成的）*工具箱*: 可从一个选单调用的一组程序或功能，如同装进*工具箱*的一套工具] <*tool case* [←(wooden, plastic or metal) *tool case*: the set of programs or functions accessible from a single menu is like a set of tools kept in a *tool case*]>

(8) is a case of extra-domain polysemy. The technical sense "the set of programs or functions accessible from a single menu" is a metaphoric extension of the non-specialized sense "a container for keeping tools in". Both senses are translated into 工具箱, resulting in complete overlap between the Chinese equivalents and indicating a link between the two senses. Because it is not easy for learners to connect a sense about "a feature of a program" to one about "a container for tools", a short explanation is provided to highlight the similarity between a menu "containing" a set of programs or functions and a case containing a set of tools.

(9) Winchester n. 【计】<computing> *温切斯特*磁盘 [←*温切斯特*连发步枪: *温切斯特*磁盘按原设计可容纳2个30兆字节的磁盘，其IBM编号为3030，恰与*温切斯特*连发步枪用0.30格林火药的0.30口径子弹相同] <*Winchester* disk [←*Winchester* rifle: The *Winchester* disk, as originally designed, can hold two 30-megabyte disks. Its IBM designation is 3030, coincidentally matching the caliber of the 0.30 cartridge used in the *Winchester* rifle, which fires 0.30 caliber bullets.]>

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Similar to (8), the overlap (i.e. the shared name 温切斯特) between the Chinese equivalents of the computing sense and the added sense indicates, rather than explicates, the link between them. It is, in fact, the shared number 3030 that connects the two senses though its meaning in one sense is different from that in the other. However, this etymological knowledge is probably beyond lay people as well as some professionals. For this reason, a short gloss is used to provide learners with the fun fact about the coincidence between the two senses.

(10) syntax n.【计】<computing> *句法* [←【语】*句法*；语法；句子结构(分析): 编程用的指令系统比作是语言，编程的规则因而比作是*句法*, 参见 PARSE, TRANSLATE, DICTIONARY 等词] <*syntax* [← <linguistics> *syntax*; grammar; (analysis of) sentential structure: the instruction systems used for programming are likened to language and, accordingly, the rules of programming are compared to *syntax*. See PARSE, TRANSLATE, DICTIONARY, etc.]>

(10) is an instance of inter-domain polysemy, where the computing sense is re-terminologization — or rather, a metaphorical extension of the added linguistic sense. As in (5), the target sense is translated using one of the Chinese equivalents of the source sense. Despite the shared equivalent 句法, learners might find it still difficult to make sense of the similarity between the two technical senses. To enable learners to benefit further from the gloss, we invoke two mappings (i.e., from the language to programming instructions and from syntax to programming rules) of the conceptual metaphor PROGRAMMING IS USING THE WRITTEN FORM OF A HUMAN LANGUAGE without resorting to linguistic jargon. Related terms are cross-referenced to reinforce the impression about the semantic regularity in these lexical items.

6. Concluding remarks

Sense links used to receive little attention in SDLs but can now be further discussed thanks to some favorable changes. For example, Descriptive Terminology has identified more polysemy within a domain than Prescriptive Terminology and removed the restriction of domain specificity to expand polysemy beyond a given domain. Interesting attempts have also been made to represent sense links systematically in formalized lexicons or demonstrate their pedagogical value in learners' dictionaries. Drawing upon insights from these studies, we proposed three guidelines and four models. Specifically, when treating intra-domain polysemy in BDSLs, lexicographers should place the source sense before the target sense and sometimes append a gloss to the target sense to explicate an obscure sense link. When dealing with inter- or extra-domain polysemy, the BDSL's focus on a single subject field must be maintained. The non-domain specific source sense needs to be added as a gloss and used as background knowledge to facilitate the understanding of the target, domain-specific

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sense. When it is difficult to relate the two senses, a short explanation is included in the gloss to make explicit the link between them.

Our research is useful in the following three ways. First, it demonstrates the feasibility of including polysemy extensively in SDLs that are supposed to be single-field dictionaries. Due to lexicographers' concern about domain specificity, there have been few attempts to exploit sense links in SDLs than in general dictionaries for learners. The present study offers practical suggestions on how to choose and treat polysemy without losing the SDL's focus on a single subject field. Second, our research incorporates the overlap between the TL equivalents of the source and target senses into the description of sense links. Sense links have been characterized chiefly in terms of the semantic intersection of the source and target senses, the regularity of their semantic distinction, and the mechanism for semantic extension. The present research proposes that the overlap between equivalents affects the perceived semantic distance between source and target senses and should be fully considered in describing sense links. Third, the study illustrates how sense links can be treated in BSDLs using computing-related polysemy. Sense links used to be represented by logical sense ordering alone. They are now further described in some research (e.g. Lu and Wei 2019; Lu et al. 2020) by means of definitions carefully crafted to reveal the shared semantic components between the source and target senses. However, these strategies are designed for non-specialized polysemy in monolingual dictionaries. They are therefore adapted to bilingual dictionaries, varied in line with the types of polysemy and embodied in four models.

Nevertheless, there is still much work to be done in advancing the study. Building on previous research in terminology and lexicography, we have proposed models for representing sense links in BSDLs with the aim of aiding learners in acquiring technical senses. Consequently, this approach primarily involves speculation. Therefore, it is necessary to conduct empirical investigations to assess the effectiveness of the models and gather feedback from users to enhance them. Additionally, the success of these models relies on the assumption that dictionary users already possess knowledge of the source sense and can utilize it as a foundation for learning the target sense. While this may hold true for extra-domain polysemy, it is less probable in the case of intra- or inter-domain polysemy, as the source sense itself is technical in nature. Hence, knowledge about morphology, etymology and even mnemonics could prove highly beneficial in helping users to grasp the source sense initially. Lexicographical research in these areas is scarce but extremely valuable for improving BSDLs.

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Endnote

1. Source sense is used in this paper to designate a sense that functions as the basis and extends to a specialized sense (which is called target sense). A source sense can be the basic or core sense of a lexical item or an extension of the basic sense.

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