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Testing the Potential of Automatically Inferred Affix Colexifications for Linguistic Typology

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Abstract

Cross-linguistic colexification patterns have proven useful for quantitative studies in lexical typology. While most studies focus on full colexification, where senses are co-expressed by the same word form, recent studies have proposed to compute partial colexifications, where senses are not colexificied by entire words, but only by parts of them. Among these, affix colexifications, where one word recurs in the end or the beginning of another word, show interesting properties, potentially reflecting word formation processes giving hints cross-linguistic motivation patterns. In order to test their potential, we conduct a detailed case study. Based on a large sample of cross-linguistic partial colexification patterns, computed from the Database of Cross-Linguistic Colexifications, we first check to which degree partial colexifications reflect true cases of lexical motivation and then carry out a detailed comparison of concept relations underlying frequent partial and full colexification patterns. Our results show that partial affix colexifications that recur across five and more language families tend to reflect true lexical motivation patterns in almost 90% of all cases. Furthermore, we find that majority of affix colexifications and full colexifications reflect contiguity relations. However, the proportion of contiguity relations in partial colexifications exceeds the proportion of contiguity relations in full colexifications (50% vs. 40%), showing that there are differences in the semantics reflected by both colexification types.

Keywords: colexification patterns; partial colexification; evaluation study; cognitive-semantic relations.

1. Introduction

In the last decade, studies investigating colexification patterns across languages have increased and brought interesting findings to light. A particular type of colexification are *partial colexifications*. These are colexifications in which the linguistic representation of two concepts does not completely overlap, as is the case of full colexification patterns, but where the linguistic expressions overlap partially instead. Among partial colexifications, a specific subgroup are those cases in which a lexeme B can be regarded as a combination of a lexeme A that was extended by additional lexical material added to the left or the right of B. This particular type of colexification, called *affix colexification* by List (2023), can be seen as a special case of the *overt marking* of semantic relations discussed in Urban (2011), offering interesting ways to study word formation patterns across unrelated languages from a concept-based (onomasiological) perspective. While the investigation of this specific kind of partial colexification has been enjoying some popularity of late, with several studies conducting cross-linguistic investigations of manually or automatically annotated data (Norcliffe and Majid 2024, Barlow 2025, Tjuka and List 2024), little is so far known about the specific potential of automatically inferred affix colexification patterns for linguistic typology. Recent studies seem to show that semantic relations inferred from affix colexifications largely differ from semantic relations inferred from full colexifications (Bocklage et al. 2024, Rubehn and List 2025). However, up to today, we do not know (1) to which degree affix colexifications reflect true cases of lexical motivation accompanying word formation processes, and (2) in what kinds of cognitive-semantic relations affix colexifications differ from full colexification patterns.

In this study, we will try to address these two questions by conducting a detailed test on partial affix colexifications inferred from a large colexification database. In the following, we will give a brief overview on full and partial colexifications, general problems of computer-assisted colexification studies, and semantic-cognitive relations between concepts (§ 2). Based on these insights, we will present a new test study that we conducted to shed light on our two key questions (§3), and present the results of this study in due detail (§4). We conclude that — to our own surprise — affix colexifications, when computed from a sufficiently large amount of data and analyzed with a certain amount of care, provide linguistic typology with a new kind of cross-linguistic analysis that can enrich ongoing research in lexical typology with interesting new insights.

2. Background

2.1. Full and Partial Colexifications

The term *colexification* was originally introduced by François (2008) in lexical typological research to facilitate the cross-linguistic comparison of the meanings denoted by individual words. Technically, colexification is a cover term for the notions of polysemy and homophony. While linguists typically try to keep these distinct, given that different processes give rise to the relations in individual languages, the notion of colexification emphasizes that the *output* of the processes leading to polysemy (semantic change) and homophony (phonological merger) are actually the same, resulting in *one word form* denoting *several senses* in a given language at a given point in time.

While in theory, the notion of colexification ignores the distinction between polysemy and homophony, enabling researchers to bypass the often challenging task of differentiating between the two phenomena when analysing larger cross-linguistic datasets, it turns out that in practice, colexification patterns shared by *many languages* across different language families are unlikely to reflect instances of homophony arising from shared patterns of language-specific historical developments. Instead, colexification patterns that can be shown to recur across several language families tend to indicate cases of polysemy resulting from shared cultural, cognitive or experiential factors across languages.

As a result, cross-linguistic colexification patterns have proven to be a useful proxy for to investigate polysemy patterns that recur across many of the world's languages, allowing for a quantitative investigation of colexification patterns along several different semantic domains, such as emotion semantics (Jackson et al. 2019, Georgakopoulos and Polis 2022), body part terminology (Tjuka et al. 2024), perception verbs (Georgakopoulos et al. 2022, Norcliffe & Majid 2024), or language development (Brochhagen et al. 2023).

In 2014, the *Database of Cross-Linguistic Colexification* was published as a first framework for the collection and curation of cross-linguistic colexification data (List et al. 2014, https://clics.lingpy.org). The data collection was continued, expanded and refined later (List et al. 2018, Rzymsi et al. 2020), culminating in the fourth installation of the database that was recently published (Tjuka et al. 2025).

While we use the term *full colexification* to refer to cases we previously described, where two meanings share one form and overlap completely, *partial colexifications* (or *loose colexifications* in the terminology of François 2008: 171), in contrast, occur when word forms denoting different senses share certain lexical material. Following ist (2023), who takes inspiration from Urban (2011), a special case of partial colexifications can be found in those cases, where a given word A recurs in a given word B in such a way, that word A occurs either in the beginning or the end of the word B. As List points out, such specific cases of *overt marking* in the sense of Urban (2011) may result from word formation. As a result, the senses that are linked by partial affix colexifications may reflect direct cases of lexical motivation.

List (2023) also introduces an algorithm that can be used to compute affix colexifications from multilingual wordlists in a computationally efficient way and gives an initial example, showing how affix colexifications can be represented in a directed, weighted network. Tjuka and List (2024) explore partial affix colexifications that link concepts denoting body parts with concepts denoting objects, providing initial evidence that partial affix colexifications may reveal semantic relations that can prove useful for investigations in lexical typology. Bocklage et al. (2024) provide a first comparison of automatically computed affix colexifications with manually annotated data on cross-linguistic processes of semantic shift, as reflected in the *Database of Semantic Shifts* (https://datsemshift.ru/, Zalizniak et al. 2024). While they conclude that the semantic relations that can be inferred from partial affix colexifications differ substantially from the relations inferred from full colexifications, they cannot confirm the hypothesis by Urban (2011), who assumes that over marking may give hints on the directionality of semantic change.

While initial pilot studies have been conducted that explore how affix colexifications can be computed and how they can be analyzed, detailed studies that investigate the further potential of partial affix colexifications for lexical typology are lacking so far. Most importantly, we do not know to which degree partial affix colexifications *coincide* with actual word formation patterns. Given that the algorithms proposed so far derive information on partial colexifications from raw word forms that lack any particular morpheme segmentation, it is quite possible that the majority of partial colexification patterns that can be inferred with the help of the algorithms by List (2023) and Blum et al. (2025) suffer from too many false positives, reflecting noise rather than meaningful signal.

2.2. Full and Partial Colexifications

When investigating full and partial colexifications in the way outlined above, the starting point of the analysis is the *concept*, as it is denoted by the individual words in individual languages. The advantage of such concept-based or onomasiological approaches (Geeraerts 2010: 23) is that they make the comparison across languages easy, given that the concept, encoded as a standardized elicitation gloss in a multilingual wordlist, serves as the starting point, the *tertium comparationis* (Koch 2001: 1143) of the comparison, or the comparative concept in the sense of Haspelmath (2010). This allows us to identify tendencies and commonalities in lexical coding across language family boundaries (Koch and Marzo 2008), while *form-based, semasiological* approaches that take individual word forms as their starting point, investigating the development of the senses expressed by etymologically related words, are restricted to patterns that can be only observed in genetically related languages. A further advantage of concept-based approaches is also that they allow us to concentrate on particular domains more directly, since we can select which concepts we want to take as a starting point, while form-based approaches would require additional steps to restrict them to particular semantic domains.

An obvious disadvantage of concept-based approaches is that they will always be restricted to the initial selection of concepts that have been sampled. While form-based approaches can in theory sample conceptual relations as fine-grained as the data allow, concept-based approaches cannot go beyond the initial list of concepts that were translated into the target languages.

An additional problem is that synchronic colexification data can also turn out to be misleading due to missing or incorrect documentation of diachronic processes. The idea that synchronic polysemy and diachronic semantic change are related has been a standard theoretical stance in cognitive linguistics studies, which view polysemy as the synchronic reflection of diachronic semantic change (Blank 1997: 406-410, see also Geeraerts 1997 and Sweetser 1990). It is now widely acknowledged that semantic change typically passes through an intermediate stage of polysemy, during which a word w in a given language L colexifies more than one sense. This transitional stage is illustrated in Figure 1, which shows that at Stage 2 word form *w* colexifies senses A and C. It is also well-established that the original sense associated with word form *w* could eventually be lost in later diachronic stages, leaving C as the only sense of form *w*. A textbook example of this process is given in Campbell (2013: 233), taking German *Zimmer* "room" as an example. Zimmer goes back to the Proto-Germanic **tem-ram*, which originally meant "building" (Sense A). At Time 2, *Zimmer* acquired a polysemous status, referring not only to "building" (Sense A) but also "room" (Sense C). In Time 3, as reflected in its contemporary usage, the sense "building" has disappeared, and *Zimmer* now denotes only "room" (Sense C).

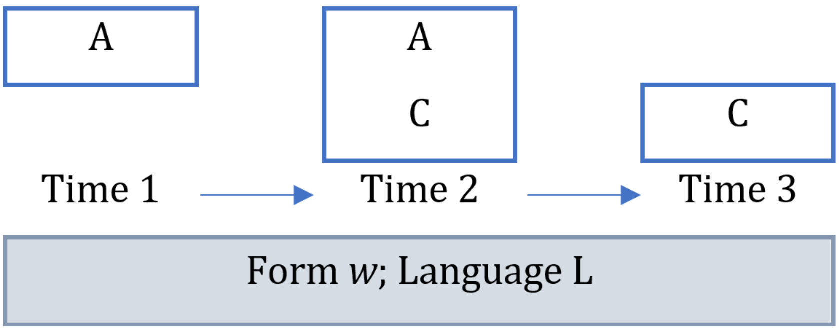

Figure 1: Schematic representation of the gradual nature of semantic change (inspired by Campbell 2013: 233).

However, the scenario in which one of the two senses of form *w*, observed at a given point in time, represents the original meaning is only *one* possible pathway. An alternative scenario — given in Figure 2 — is that the word initially denoted sense B (Time 1), which was later extended to include sense C (Time 2). At a later stage, form *w* acquired another sense, A, while the original sense B was lost. This development results in the colexification of senses A and C, although one would normally not observe this colexification as an immediate result of semantic change. The actual relationship between the colexifications is therefore not always straightforward. Instead, in many cases knowledgeable native speaker's or scholar's judgements based on etymologies, dictionaries or other documentation are the only remedy for dispelling ambiguities about the actual direction of development (Koch and Marzo 2007: 282f). As a result, we can conclude that an observed colexification between two senses *may* reflect a semantic change process and thus provide evidence for a plausible pattern of semantic shift. It does, however, not necessarily need to point to direct processes of semantic change.

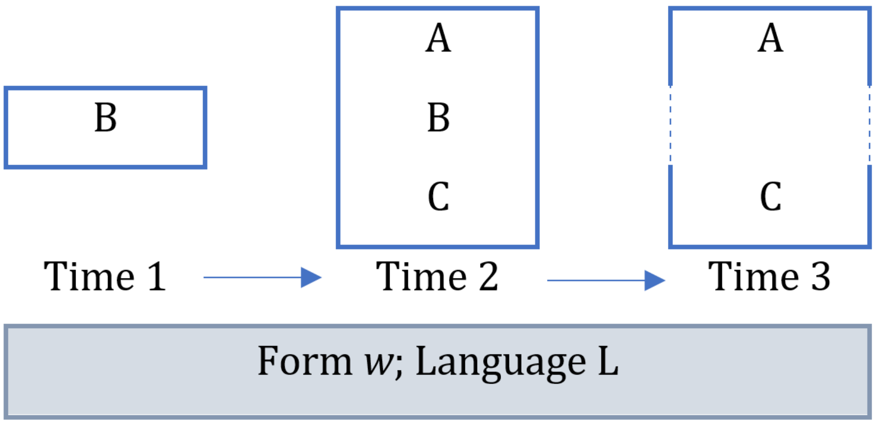

Figure 2: Schematic representation of the gradual nature of semantic change including meaning loss (inspired by Campbell 2013: 233).

What holds for full colexifications holds even more so for partial colexification data. Since word formation occurs much more frequently than semantic shift, observing that one word recurs in the beginning or the end of another word does not necessarily reflect true cases of lexical motivation between the senses denoted by the source word and the target word form. In Catalan, for example, *temps* in the meaning of "weather" and *molt de temps* in the meaning of "for a long time" represent a clear-cut affix colexification in the sense of List (2023). However, this does not mean that "for a long time" can be motivated as going back to "weather". What happened instead is that the word denoting "time" in Catalan, *temps*, experienced a polysemic extension, being also used to denote "weather" (a common colexification, as can be seen from the CLICS database). The phrase "for a long time" then reflects the original meaning of *temps*, rather than the derived meaning "weather". The semantic relation thus arises between "time" and "for a long time" rather than between "weather" and "for a long time". This shows that what holds for full colexifications also holds —

maybe even more — for partial colexifications. They can provide hints on actual processes of lexical motivation, but if two words occur in an affix colexification relationship, it does not necessarily mean that the senses that the words denote reflect diachronic semantic relations.

A final set of problems may result from the translation process itself. While form-based approaches that take dictionaries as a starting point would capture all kinds of senses that a given lexeme can express in given language, the process of translating a concept into a given target language may meat several complications. Thus, it is often difficult to distinguish concepts clearly, specifically when working cross-linguistically, with a large number of languages, for which resources are often limited. Since languages organize the conceptual space in remarkably different ways, this "onomasiological fuzziness" (Grzega 2004: 22) can result in translation problems, when dealing with concepts for which a given language lacks a clear expression. While cases like "arm" and "hand", which are colexified in many of the world's languages, are well understood, it may still be difficult to deal with them in an appropriate manner when dealing with data from different sources. Thus, if confronted with a questionnaire that only asks for "arm" and "hand" as concepts, informants might feel forced to provide expressions that come close to exact translations for both terms, even if their colloquial language use would use a third concept that colexifies both concepts. As a result, the collection of full and partial colexification data from different sources may suffer from unnoticed errors introduce through the original datasets. Since colexification studies usually intent to include as many data from as many different languages as possible, it is obvious that it is impossible to avoid all errors. However, it is difficult to say, to which degree the errors occurring in large data collections may actually influence the results of particular analyses.

2.3. Semantic-Cognitive Relations Underlying Full and Partial Colexifications

When innovating meaning, language users establish a relation between the source and the target meaning of a word (Koch 2016: 31). The semantic change of a word from meaning A to B and the resulting polysemy is thus in most cases based on this association of the underlying concepts (Blank 1997: 148). The associative process is not the single cause of semantic developments, but it usually constitutes their motivational foundation (Sperber 1923: 33-34; Blank 1997: 34). While the relevance of underlying associative cognitive relations has long been established (Koch 2016:

22) there are other formal ways of realizing the same semantic-cognitive relationship between two concepts (Koch & Marzo 2007: 260-261). Consider, for example, the two opposing meanings of “renting” an apartment and “letting” an apartment. While both Spanish and English have a polysemous word covering both senses (Spanish *alquiler*, English *to rent*, called auto-converse change by Blank 1999: 74), German uses *mieten* and the derived *vermieten* to express the same relation. What holds for polysemy also applies to other word formation processes that involve morphological or syntactic alteration of the predecessor expression: The lexicalization of new words as derivations of existing ones is preceded by an association of the underlying concepts (Blank 1997: 148-151). The cognitive relations between associated concepts can thus not only be realized through polysemy, i.e., through a single lexical item, but also through other derivative word formation types, i.e., through different lexical items (Koch & Marzo 2007: 261-262; Apresjan 1974: 18; Gévaudan & Koch 2010: 20-21; Urban 2011: 6). Words that are derived from others thus not only share a morphological but also a semantic relation, which can be seen as two related dimensions of lexical motivation (Koch & Marzo 2007: 260). In this sense, polysemy and word formation are comparable, productive types of *lexicalization* (Koch & Marzo 2007: 261-262; Apresjan 2009: 18), as illustrated in Figure 3.

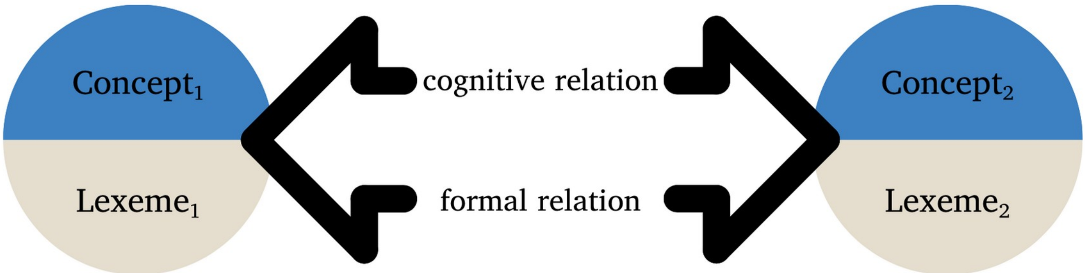

Figure 3: Semantic-cognitive and formal relation as two dimensions of lexical change (inspired by Koch's "motivational square" from 2001: 1156. Lexeme$_1$ and Lexeme$_2$ can be represented by the same form (polysemy) or two different forms where one is derived from the other (word formation).

The results of various association tests conducted at the beginning of the 20th century confirmed what had already been asserted even since the time of Aristotle: that there are essentially only three basic principles of association: *contiguity*, *similarity* and *contrast* (Blank 1997: 138-140; Koch & Marzo 2007: 269). Concepts or words that are not linked via one of these relations thus have no associative relationship to each other (Blank 1997:143-144). The three principles can combine in different ways resulting in a set of seven cognitive relations that are useful to describe the motivational basis of lexical change across languages (Koch & Marzo 2007: 269).

Contiguity is based on the some kind of contact between concepts (Blank 1997: 233). Two concepts are related by contiguity if they are spatially, temporally, logically or in another perceivable way connected to each other (Blank 1997: 33), so they are contiguous if they occur in the same experiential context (Gévaudan 2007: 83; Blank 1997: 143). Contiguity is the motivational basis of *metonymy* and also of *synecdoche* (Gévaudan 2007: 83, 91; Blank 1997: 199, 232), which yet is itself a special kind of metonymy (Urban 2015: 7; Wilkins 1996: 275) and therefore will not be treated separately. Every contiguous relation takes place within one domain, which itself consists of several contiguity relations (Gévaudan 2007: 83; Gévaudan & Koch 2010:. 20). Due to this special type of cognitive relation between two concepts within a domain, the contiguity relation can appear as a particularly economical way for the linguistic expression of concepts having semantic-pragmatic advantages (Blank 2001: 245-246).

Similarity is the association of concepts based on the similarity of perceived concept properties or abstract analogies (Gévaudan 2007: 83-84). It is the motivational basis of the mechanism of metaphor (Gévaudan 2007: 83). The aspects that are shared or perceived as similar between concepts concern form, movement or function and can be of secondary or nonessential nature (Blank 2001: 43-44). As *metaphorical similarity* is based on establishing parallels and analogies between concepts, a central property of most such relations is the connection of concepts across different domains or frames (Blank 2001: 43-44; Gévaudan & Koch2010: 21). However, in some cases we encounter "intrafield [metaphors]" (Wilkins 1996: 274; see also Matisoff 1978) where both the source and target concepts appear to belong to the same taxonomic domain, yet can be grouped separately from another perspective, thus enabling the analogy (Barcelona 2011: 36-43). Take for example the frequent colexification of "knee" and "elbow" which both belong to the body part domain (for examples on language families, where the colexification frequently occurs, see Tjuka et al. 2024). When focussing on the limbs they are part of, the "knee" belongs to the leg and "elbow" to the arm. The colexification is therefore motivated by their analogue function within different bodily extremities and thus based on metaphorical similarity.

Metaphorical similarity should be distinguished from *co-taxonomic similarity*. Concepts in this relation are similar in that they belong to the same level of abstraction of a taxonomy (Gévaudan & Koch 2010: 21) Co-taxonomic similarity motivates the semantic process of cohyponymic transfer which relates cohyponyms that are subordinate concepts assigned to the same superordinate concept and share a certain degree of similarity (Blank 2001: 43-44). Concept pairs that are co-taxonomically similar can show strong or little contrast to each other (Blank 1997: 107).

Taxonomic inclusion is based on the relationship between sub- and superordinate terms and, unlike co-taxonomic connections, refers to vertical rather than lateral relations within a taxonomy. As elements of the same taxonomy, superordinate and subordinate terms, too, exhibit a certain degree of similarity (Blank 1997: 140). Such vertical taxonomic relations have often not been sufficiently considered by cognitive semantic research and reduced to other associations by prototype theory. Yet, due to their determinate directionality, they qualitatively differ significantly from other similarity or contiguity relations, so that they must be dealt with separately (Gévaudan 2007: 88). Based on the directionality of the relation, we can distinguish taxonomic sub- from taxonomic super-ordination. *Taxonomic super-ordination* describes relations going from a subordinate concept to a superordinate concept (Blank 2001: 43-44) and is the motivational basis of generalization. Here, the designation of a concept on a higher taxonomic abstraction level is used to express a concept which ranks lower in taxonomic abstraction (Gévaudan & Koch 2010: 21]. *Taxonomic sub-ordination* represents the opposite relation going from a superordinate to a subordinate concept. It results from using an expression of concept ranking lower in abstraction for a concept ranking higher (Blank 2001: 43-44; Gévaudan 2007:101-103, Gévaudan & Koch 2010: 21) and motivates specialization.

Contrast is understood as the scalar opposite of similarity (Blank 1997: 155). However, they do not exclude, but rather condition each other. A certain minimum level of similarity is necessary in order for a contrast between concepts to be recognized (Blank 1997: 155). A contrast without any similarity would instead yield to no perceived relation at all. Contrasting concepts are opposing counterparts that are minimally similar. Likewise, even the maximal degree of similarity requires a minimal basic degree of contrast, as maximal similarity without contrast would result in identity (Blank 1997: 142-143).

Two concepts are identical if their semantic relational is continuous, i.e. without any variation in meaning (Gévaudan & Koch 2010: 20) and if their intensions and extensions are fully congruent (Gévaudan 2007: 86]. Thus, *identity* is an extreme form of similarity between concepts without any contrast (Blank 2001: 43-44; Blank 1997:

142-143). Yet, compared to the other cognitive relations, identity is less relevant for lexical semantics as it excludes semantic change per definition (Blank 2001: 43-44).

2.4. Common Tendencies in Semantic Change and Word Formation

Many studies show that semantic change and thus polysemy is not random and follows certain tendencies across languages, for example, the tendency of words to develop relatively *subjective meanings* from relatively *objective meanings* (Sweetser 1990; Viberg 1984; Traugott & Dasher 2002; Brown & Witkowski 1981; Evans & Wilkins 2000; Wilkins1996; Starostin 2013). For instance, it is now widely accepted that semantic change commonly follows a unidirectional path. Some factors shaping semantic change include *concreteness* (Monaghan 2014; Fugikawa et al. 2023; Winter & Srinivasan 2022; Xu et al. 2017), *imageability* (Vejdemo & Hörberg 2016), *frequency of use* (Hamilton et al. 2016; Vejdemo & Hörberg 2016; Khishigsuren et al. 2025; Fugikawa et al. 2023; Kawasaki et al. 2020; Winter & Srinivasan 2022), *age of acquisition* (Monaghan 2014; Monaghan & Roberts 2019; Baumann & Hartmann 2025) *valence* (Fugikawa et al. 2023) and *markedness* (Witkowski & Brown 1985; Viberg 1984; Norcliffe & Majid2024a? + + +) of affected words. Trends can also be observed with respect to the semantic-cognitive associations between concept pairs: for example, concepts that are semantically more similar or related to each other tend to colexify more frequently (Xu et al. 2020; Karjus et al. 2021; Brochhagen & Boleda 2022). However, the colexification of concepts that are too similar — potentially leading to which communicative malfunction or confusion — is typically avoided (Karjus et al. 2021; Brochhagen & Boleda 2022). In addition, Tjuka et al. (2024), in their study of the factors shaping body part vocabularies across languages, found that most colexifications between body parts are based on the perceptual feature of contiguity, rather than on function or shape. This suggests that, although the structure of body part lexicons varies across language families, certain dimensions, such as contiguity, are more stable than others and may indicate universality.

Although there is less empirical evidence regarding conceptual relations underlying word formation (Pepper 2022: 330), the available research indicates that they follow distinct patterns, differing from those observed in polysemy. For instance, it seems that contiguity motivates a great part of derivative morphology (Bauer 2017: 11f), showing the tendency to be more prevalent and diverse in word formation rather than in polysemy (Janda 2011: 380-385). Janda (2011 389) finds that, although some contiguity-based relations are shared between polysemy and derivative word formation, many such relations occur exclusively in word formation.

The results of Khishigsuren et al. (2022) on metonymy in comparison to Srinivasan & Rabagliati's (2015) findings on polysemy indicate as well that certain contiguity based relations might tend to be expressed through word formation. Both studies find cross-linguistically shared patterns of connections between semantic categories, such as "plant" for "food" and "container" for "content". However, in contrast to Srinivasan & Rabagliati (2015) who only consider polysemous relations, Khishigsuren et al. (2023) also include contiguity based concept connections realized by means of word formation. While the Hungarian participant in Srinivasan & Rabagliati's (2015: 138) study rejected polysemous realizations of the SUBSTANCE FOR ACTION pattern, Khishigsuren et al. (2023) find several instances of this pattern in Hungarian realized through "morphological metonymy" (Khishigsuren et al. 2023: 2391), which again hints at diverging cognitive patterns underlying the two phenomena and underlines the relevance of contiguity in word formation.

Trends observed in the body part and in the perception lexicon point in the same direction: A bias for partial colexification can be observed if body parts metaphorically extend their meaning crossing domain boundaries: the relation between the body part source concept and the target concept tends to be mediated by a complex expression (Brown & Witkowski 1981: 605; Law 2023: 308). A bias against full colexification can be observed for the perception verb "to see" within the perception verb domain, where the verb is most frequently expressed by a simple, dedicated lexeme (Viberg 1984; Viberg 2001; Norcliffe & Majid 2024a: 20-23). These findings might hint at distinct functions assigned to polysemy and word formation within and across domains, which could reflect different cognitive pattern beneath.

The differences between the patterns of cognitive relations underlying polysemy and word formation also appear plausible in light of research findings showing that concepts are above all fully colexified if they are similar enough to be associated but not too similar to be confused (Brochhagen & Boleda 2022: 6) . Partial colexifications could then be used for disambiguation, when full colexification could jeopardize communicative success, and therefore rely on other cognitive relation patterns (Bocklage et al. 2024: 23).

Despite these indications, a more detailed and extensive investigation of the cognitive relations underlying word formation or partial colexification patterns in general and across languages is still needed (Bocklage et al. 2024: 25; Hledíková &

Ševčíková 2024: 98-99; Khishigsuren et al. 2023: 2391; Pepper 2022: 330; Janda 2014: 347-348; Janda 2011: 389). In the following, we will try to narrow the gap by testing how well frequently recurring partial colexifications reflect actual word formation processes and by investigating the semantic-cognitive patterns underlying a sample of frequently recurring full and partial colexifications.

3 Materials and Methods

3.1 Materials

Our starting point is the recently published fourth installation of the *Database of Cross-Linguistic Colexifications* (CLICS 4, Tjuka et al. 2025). CLICS 4 offers automatically inferred information on full colexification patterns, taken from 95 different datasets. In contrast to previous versions of CLICS, such as CLICS 2 (List et al. 2018) or CLICS 3 (Rzymski et al. 2020), CLICS 4 increases not only the number of individual datasets from which colexification information is inferred, but also introduces additional improvements with respect to concept handling, language selection, and data representation. All in all, CLICS 4 offers 3986 colexification patterns inferred from 3432 language varieties, corresponding to 2152 distinct Glottocodes (based on Glottocode 5.2.1, Hammarström et al. 2025). Since CLICS 4 offers only information on full colexifications, we computed affix colexification data from CLICS 4, using a novel approach described by Blum et al. (2025, see § 3.2.1).

3.2 Methods

3.2.1 Inference of Partial Colexifications

While full colexifications used in our study are directly taken from CLICS 4, affix colexifications were not provided with this version and had to be computed by ourselves. In order to compute partial colexifications, we follow the approach reported in Blum et al. (2025) and apply it to the CLICS 4 dataset. The approach by Blum et al. makes use of the fact that the CLICS 4 data are shared as a CLDF dataset, following the standards proposed by the Cross-Linguistic Data Formats initiative (Forkel et al. 2018). Since CLDF datasets can be directly converted to SQLite databases, they can be searched and queried in a computationally efficient manner, using SQL queries. While Blum et al. apply their query to Lexibank, a repository of 134 CLDF wordlists, for partial affix colexifications, we applied the same query to the CLICS 4 dataset.

The analysis yields a list of 342 261 individual affix colexifications, corresponding to 155 913 distinct colexification patterns, covering 247 different languages families and 3389 different language varieties. When taking only those colexification patterns into account that recur in at least five distinct language families, the large number of individual colexification patterns shrinks to 5508 patterns.

3.2.2 Error Analysis of Automatically Inferred Partial Affix Colexifications

Ideally, a partial colexification corresponds to an actual semantically motivated word formation. Due to the aforementioned biases, it can be assumed that this is not always the case. Using a five category scheme, we therefore carried out a detailed investigation of 50 individual language varieties from 12 language families conducted by 8 different annotators. Although the selection of languages followed the individual competences of our research team, we find that the coverage in languages is globally quite satisfying, with languages from a diverse range of different families, as can be seen from the data in Figure 4 and Table 1.

A partial colexification is considered a “True Colexification” if the partial colexification represents a semantically motivated relation of the concepts. If the segmentation of the partial colexification relation is justifiable but does not accurately represent the complete semantic architecture driving the colexification, for example by skipping developmental steps, the relation is assigned to the category “Segmentation Issue”. As a word can be mapped to several concepts, a partial colexification can be based on a concept which represents an actual meaning of the word but not the actual lexical motivation of the colexification. In these cases, we assign the partial colexification to the category “Incongruent Motivation”. If the partial colexification results from the algorithm matching sequences that are in no actual relation, the concept relation is only coincidental and is classified as “Algorithmic Problem”. Ultimately, individual partial colexifications may result from a problematic concept translation in the original data, if the concept mapped to the word does not represent an actual meaning of that word. These cases belong to the category “Translation Problem”.

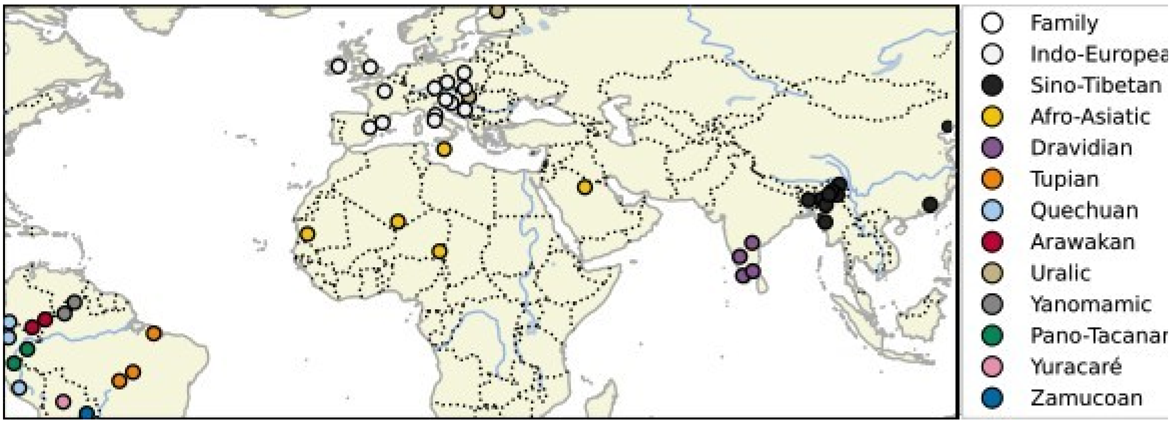

Figure 4: Map of the language families included in our sample.

Examples for this evaluation schema are shown in Table 2. As can be seen from the table, the colexification between ANT and ANTEATER in English is labeled as “True Colexification”, given that English *ant* recurs directly in English *ant-eater*, with a clear and transparent motivation. The colexification of BEAT and TRAP (CATCH) in Hungarian, however, is labeled as “Segmentation Issue”, since Hungarian *csapdaba ejt* for TRAP (CATCH) was not directly derived from Hungarian *csap* “to beat” but from Hungarian *csapda* “trap”, which in turn is derived from *csap*. Hungarian *csapda* “trap” then gives rise to the phrase *csapdaba ejt*, which literally means “catch into a trap”. In the case of the colexification of SUN and THROAT in Awetí, we find an “Incongruent Motivation”, given that Awetí [k^{w} a t] fully colexifies “sun” and “hole” and the actual motivational basis for the expression of THROAT is HOLE instead of SUN. The partial colexification of HOLE and THROAT, on the other hand, is also part of our Awetí sample and is consequently classified as “True Colexification”. The case of SEA and LEAVE in Spanish is characterized as an “Algorithmic Problem”, given that Spanish *mar* “ocean” does not recur in *marcharse* “leave, go away”, since the fact that *mar* recurs in *marcharse* is a pure historical coincidence. In the case of the colexification of DUST and SHARPEN (SOMETHING) in Malayalam, we find a “Translation Problem”, since SHARPEN (SOMETHING) is not an actual conceptual meaning assigned to Malayam [p o ɖ i k^{j}ː u g a] which instead means “to powder”.

Language	Glotto-code	Family	Anno-tator	Language	Glotto-code	Family	Anno-tator
(Arabic) Ắdirar	hass1238	Afro-Asiatic	G	Maring	mari1416	Sino-Tibetan	G
(Arabic) Bḗṛān	alge1240	Afro-Asiatic	G	Matses	mats1244	Pano-Tacanan	E
Awetí	awet1244	Tupian	H	Meixian	yuet1238	Sino-Tibetan	G
Ayoreo	ayor1240	Zamucoan	H	Napo Lowland Quichua	napo1242	Quechuan	H
Burmese (Spoken Rangoon)	mand1476	Sino-Tibetan	G	Ninam	nina1238	Yanomamic	E
Catalan	stan1289	Indo-European	C	Nocte	noct1238	Sino-Tibetan	G
Chokri	chok1243	Sino-Tibetan	G	Phom	phom1236	Sino-Tibetan	G
Croatian	croa1245	Indo-European	B	Polish	poli1260	Indo-European	B
Czech	czec1258	Indo-European	B	Quechua Ayacuchano	ayac1239	Quechuan	E
Deng_Darang_Taraon	diga1241	Sino-Tibetan	G	Resígaro	resi1247	Arawakan	H
Dimasa	dima1251	Sino-Tibetan	G	Serbo-Croatian	sout1528	Indo-European	B
English	stan1293	Indo-European	D	Shoa Arabic	chad1249	Afro-Asiatic	G
Finnish	finn1318	Uralic	C	Slovak	slov1269	Indo-European	B
French	stan1290	Indo-European	F	Slovene	slov1268	Indo-European	B
Garo_Garo	garo1247	Sino-Tibetan	G	Southern Pastaza Quechua	sout2990	Quechuan	H
German	stan1295	Indo-European	F	Spanish	stan1288	Indo-European	F
Hungarian	hung1274	Uralic	C	Standard Arabic	stan1318	Afro-Asiatic	G
Irish	iris1253	Indo-European	D	Suzhou	suzh1234	Sino-Tibetan	G
Italian	ital1282	Indo-European	H	Tamil	tami1289	Dravidian	A
Jingpho	jing1260	Sino-Tibetan	G	Tapirapé	tapi1254	Tupian	H
Kakataibo	cash1251	Pano-Tacanan	E	Tariana	tari1256	Arawakan	H
Kannada	nucl1305	Dravidian	A	Telugu	telu1262	Dravidian	A
Latin	lati1261	Indo-European	C	Urubu Kaapor	urub1250	Tupian	H
Malayalam	mala1464	Dravidian	A	Yanomam	yano1261	Yanomamic	E
Maltese	malt1254	Afro-Asiatic	G	Yuracaré	yura1255	Yuracaré	H

Table 1: Language varieties in our annotated sample.

Category	Language	Source C.	Source F.	Target C.	Target F.
True Colexification	English	ANT	[æ n t]	ANTEATER	[æ n t iː t ə ɹ]
Segmentation Issue	Hungarian	BEAT	[tʃ a p]	TRAP (CATCH)	[tʃ a p d aː b a e j t]
Incongruent Motivation	Awetí	SUN	[kʷ a t]	THROAT	[ʔ a j kʷ a t]
Algorithmic Problem	Spanish	SEA	[m a ɾ]	LEAVE	[m a ɾ tʃ a ɾ s e]
Translation Problem	Malayalam	DUST	[p o ɖ i]	SHARPEN (SOMETHING)	[p o ɖ i kʲː u g a]

Table 2: Examples for the error codes used in our evaluation study.

3.2.3 Annotating Cognitive Relations between Concepts Pairs

In order to investigate the most common cognitive relations underlying partial affix colexifications, we decided to annotate the 1000 most frequently recurring full colexifications from CLICS 4 (determining frequency of recurrence by the number of distinct families in which a particular colexification is reflected), as well as the 1000 most frequently recurring partial colexifications from the affix colexification analysis applied to the CLICS 4 dataset as our starting point.

For the partial colexification data, we first selected all colexification patterns that occur in at least 9 different language families. This yielded a list of 1368 colexification patterns, from which we retained 1094 in our final list. For the selection of full colexifications, we took all 966 colexification patterns that recur in at least 5 different language families and added 34 additional colexification patterns that only recur in 4 language families. From this list of 1000 initial patterns, we retained 959 in our final list, after excluding certain patterns, such as numerals and kinship terms (see below for details).

We then annotated the observed cognitive relations between all concept pairs in both samples, using an annotation scheme, based on a framework developed by Koch (2001: 1159f and 2007: 269) and Gévaudan (2007: 110-114). The annotation schema is given in Table 3, along with examples for *polysemy* and *word formation* processes (corresponding to full and partial colexifications).

While we consider both cognitive and semantic descriptions as useful and valid, we decided for a cognitive description, since it comes with the advantages that it captures synchronic relations between words or concepts without metalinguistic interpretation (Gévaudan 2007: 112f). Consequently, we adapt the cognitive relations of *contiguity*, *similarity*, *co-taxonomic similarity*, *taxonomic sub-ordination*, *taxonomic super-ordination* and *contrast* as category labels for our annotation.

The relation between two concept pairs is labeled as *contiguity* if the concepts have a perceivable spatial, temporal or logical connection. It is labeled as *similarity* if the relation is based on perceived parallel properties, such as same or similar form, movement or function, or abstract analogies. Most similarity relations cross domain boundaries, however, in some cases concepts from the same domain are related by similarity. If the concepts are subordinate of the same superordinate concept and bear a certain similarity we label them as *co-taxonomic similarity*. If the relation is directional and goes from a subordinate to a superordinate concept we annotate it as *taxonomic super-ordination* (generalization), the opposite relation is labeled *taxonomic sub-ordination*. *Contrast* is assigned to concepts which are in a co-taxonomic relation but show minimal similarity. The semantic relations we find here ranges from *antonyms*, via *reverses* to *converses*. However, we also label concept pairs as contrast if their semantics is in opposition but they are not part of a taxonomic class (for example if they belong to different ontological categories). As a result, we would classify the relation between “language” and “mute” as contrast, as well as the relation between “water” and “thirst”.

cognitive relation	**semantic process**	**formal realization**	
		polysemy	**word formation**
contiguity	metonymy	Nepali *khuṭṭā* LEG <> FOOT	Spanish *pie* > *dedo del pie* FOOT > TOE
similarity	metaphor	Estonian *küüs* FINGERNAIL <> CLAW	Meixian [p^{h}i^{11}] > [su^{53}p^{h}i^{11}] SKIN > BARK
co-taxonomic similarity	cohyponymic transfer	Cashibo [βai] ROAD <> PATH	Shoa Arabic *amis* > *awaltamis* YESTERDAY > DAY BEFORE TOMORROW
taxonomic sub-ordination	specialization	Modern Greek *γυναίκα* WOMAN <> WIFE	Ninam [wãro] > [wãrooʃe] MALE PERSON > BOY
taxonomic super-ordination	generalization		Finnish *kana* > *kananpoika* HEN > CHICKEN
co-taxonomic contrast	opposition	Ayoreo *bisi-'di* MEDICINE <> POISON	Deng Darang Taraon [pɹɑ^{55}] > [pɹɑ^{55}jim^{55}] GOOD > BAD
NA	NA	EAT <> NOT	THAT > THEY

Table 3: Annotation scheme for cognitive concept relations and semantic processes underlying semantic change through polysemy and word formation, used to characterize full and partial colexifications in our study.

Koch (2001: 1159) and Gévaudan (2007: 110) also propose the category of *identity*. We omit this category because the concept pairs we annotate for their relation represent semantic developments for which it is presupposed that the semantic value of the involved concepts is not identical.

3.3 Implementation

Annotation analyses were carried out with the help of traditional tools for spreadsheet annotation and are provided in the form of CSV files. The inference of partial affix colexifications was carried out with the help of an SQLite query designed for this purpose. Python scripts were used to analyze the annotations and to compute basic statistics. All data and code needed to replicate the studies reported here are available from the supplementary material accompanying this study.

4. Results

4.1 Error Analysis

For the 50 language varieties in our sample, varying numbers of partial affix colexifications were computed. The annotators responsible for individual language varieties would check them and assign each partial affix colexification observed for each of the languages in our sample to one of the five categories that we introduced in §3.2.2, namely *Motivation* (true positive), *Incongruence* (no direct case of lexical motivation, but also no direct error), *Segmentation* (no direct case of lexical motivation, due to a segmentation problem), *Algorithm* (false positive due to wrong segmentation), and *Translation* (false positive due to problematic translations).

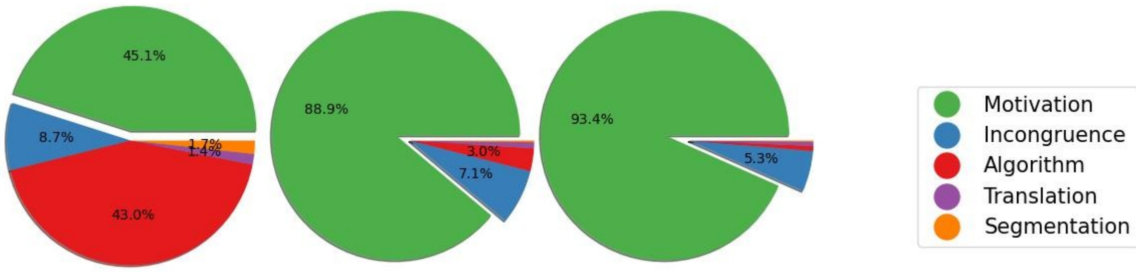

Figure 5: Summary of the error analysis for varying thresholds. The left chart summarizes errors for all observed colexifications, the chart in the middle only considers affix colexifications that recur in five and more language families, and the final chart on the right is restricted to colexification patterns recurring in ten and more languages families.

From each analysis provided for the 50 different language varieties in our sample, we calculated error proportions in three flavors, by (1) calculating proportions for all affix colexifications observed for each language variety, (2) calculating proportions for affix colexifications recurring in five and more language families, and (3) for affix colexifications observed in at least ten language families. The results of this analysis, averaged for all language varieties in our test sample, are given in Figure 5. As can be seen from this figure, the number of cases judges as reflecting true pattern so lexical motivation drastically increases when restricting the examples to those pattern that recur across several language families. Thus, while we find a lot of noise and many algorithmic errors when concentrating on *all* affix colexifications identified by the algorithm, we observe only 45% of true positives, and a large 43% of algorithmic errors. However, setting the threshold to five language families drastically reduces these errors to only 3%. When increasing the threshold further, as many as 93% of all observed cases of affix colexifications reflect true cases of lexical motivation, according to our annotations.

From these results, we can conclude that the method we used to compute partial affix colexifications from large multilingual wordlists is indeed not very exact when considering only individual language varieties. When setting the varieties in context to each other, however, our analysis shows that the majority of patterns recurring across five and more language families reflect true cases of lexical motivation. This result has important implications for future studies on partial colexifications. It shows that we can trust the patterns inferred from partial affix colexification analyses, as long as we filter them by frequency.

4.2 Concept Relations

Table 4 contrasts the results of our annotation of concept relations for full and partial colexifications. As can be seen from this table, we find a reasonable amount of differences in the concept relations reflected by partial and full colexification patterns. Although contiguity is the most frequently recurring conceptual relation observed in both colexification types, our analysis shows that the relation is much more typical for partial affix colexifications — where it constitutes more than 50% — than for full colexification patterns where 40% of all relations reflect contiguity relations. For relations based on similarity, we find the opposite situation. Here, 15% of all partial affix colexifications reflect similarity relations, contrasting with 22% of all full colexification patterns. This trend — that partial affix colexifications seem to favor contiguity relations more than full colexifications — is also reflected in the cases of taxonomic inclusion (which can be seen as a special type of contiguity) and co-taxonomic similarity (which can in turn be seen as a special similarity type). In the former case, taxonomic inclusion constitutes 19% of all partial affix colexifications, as opposed to 15% of all full colexifications. In the latter case, co-taxonomic similarity is restricted to 11% of partial affix colexifications, compared to 19% of the full colexifications.

Relation	Partial Colexification		Full Colexification	
contiguity	557	50.91%	382	39.83%
similarity	161	14.71%	211	22.00%
contrast	32	2.93%	22	2.29%
taxonomic inclusion	209	19.10%	146	15.22%
co-taxonomic similarity	116	10.60%	181	18.87%
NA	19	1.74%	17	1.77%
Total	**1094**	**100.0%**	**959**	**100.0%**

Table 4: Comparing cognitive-semantic relations in full and partial colexifications.

While these results seem to confirm the observed tendency that the semantic relations accompanying word formation more often reflect contiguity than other relations, we can see that there is a similar trend for the semantic relations resulting from polysemy in the case of full colexifications, although the trend itself is less pronounced. All in all, the analysis seems to confirm the assumption that there the semantic relations reflected by partial affix colexifications are different in nature than the semantic relations reflected by full colexifications.

4.3 Comparing Colexification Networks

In order to illustrate the differences between partial and full colexification patterns in more detail, Figure 6 and Figure 7 show a small part of the partial and full colexification network inferred from the CLICS 4 data, taking BEAK as the central concept along with its first and second degree neighbors. In the partial colexification network, four concepts are immediately connected to BEAK. MOUTH and BIRD link to BEAK — which means that both words denoting both MOUTH and BIRD across several language families in CLICS 4 recur the word for BEAK. BEAK itself links to NIPPLE and NOSTRIL — which means that the word for BEAK in several languages recurs in the words for NIPPLE or NOSTRIL.

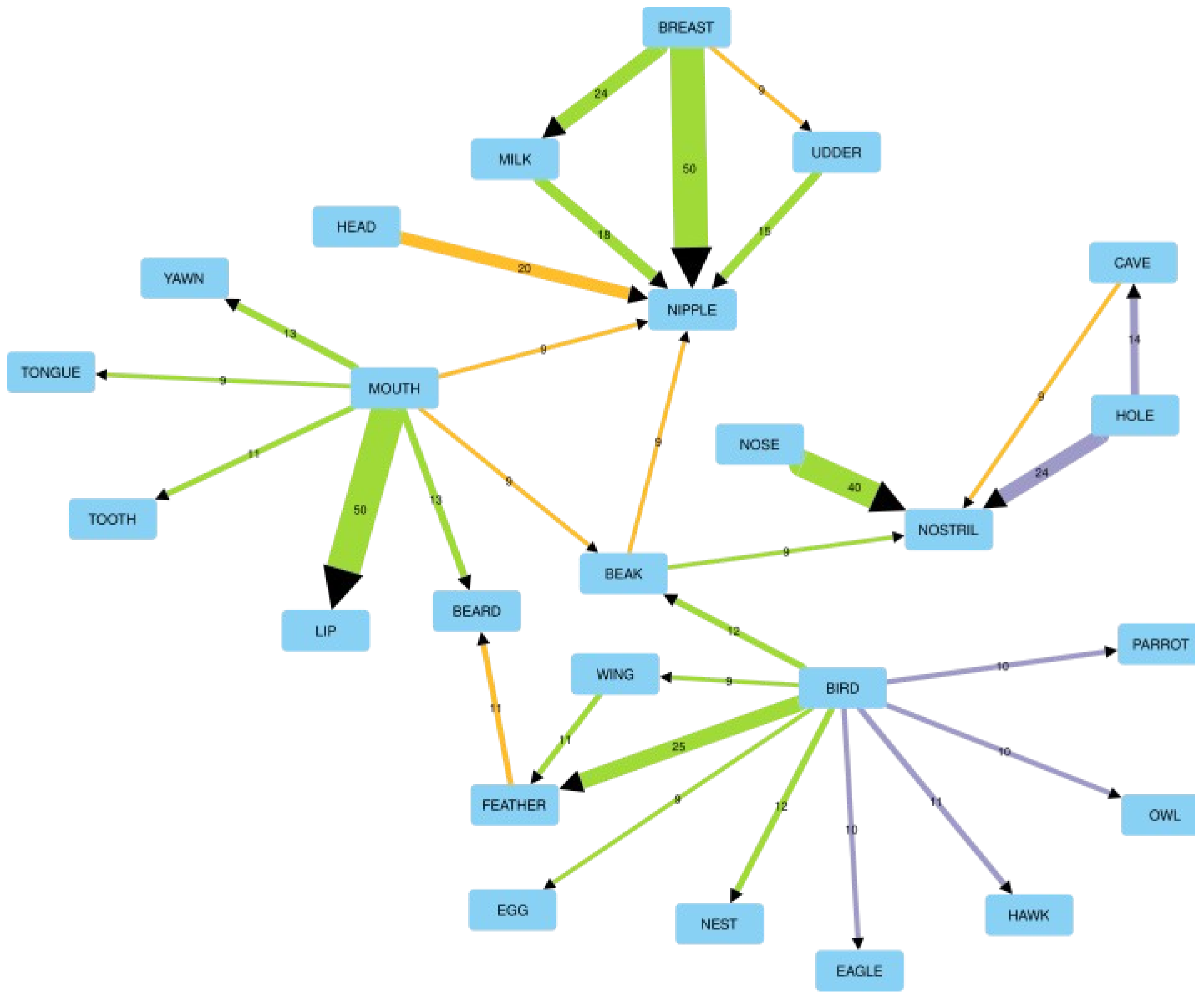

Figure 6: *Partial colexification network, generated from CLICS 4. The network shows the concept BEAK and its first and second degree neighbours (green indicated contiguity, orange similarity, and purple taxonomic inclusion; the edges' width and the number as label indicate the number of families in which a colexification occurs).*

In the full colexification network, BEAK is linked to MOUTH, NOSE and LIP, which means that there are full colexifiations for BEAK and MOUTH, BEAK and NOSE, and BEAK and LIP in the data observed.

While the overwhelming majority of relations in the BEAK network for partial colexifications seem to reflect contiguity relations (as indicated by green links in the network graphic), we can see that the picture changes slightly in the full colexification network. Although here as well, the majority of relations reflect contiguity, we find a much higher amount of similarity relations as well.

The visualizations seem to confirm again that concept relations derived from word formation processes substantially differ from the polysemy relations derived from large-scale colexification networks.

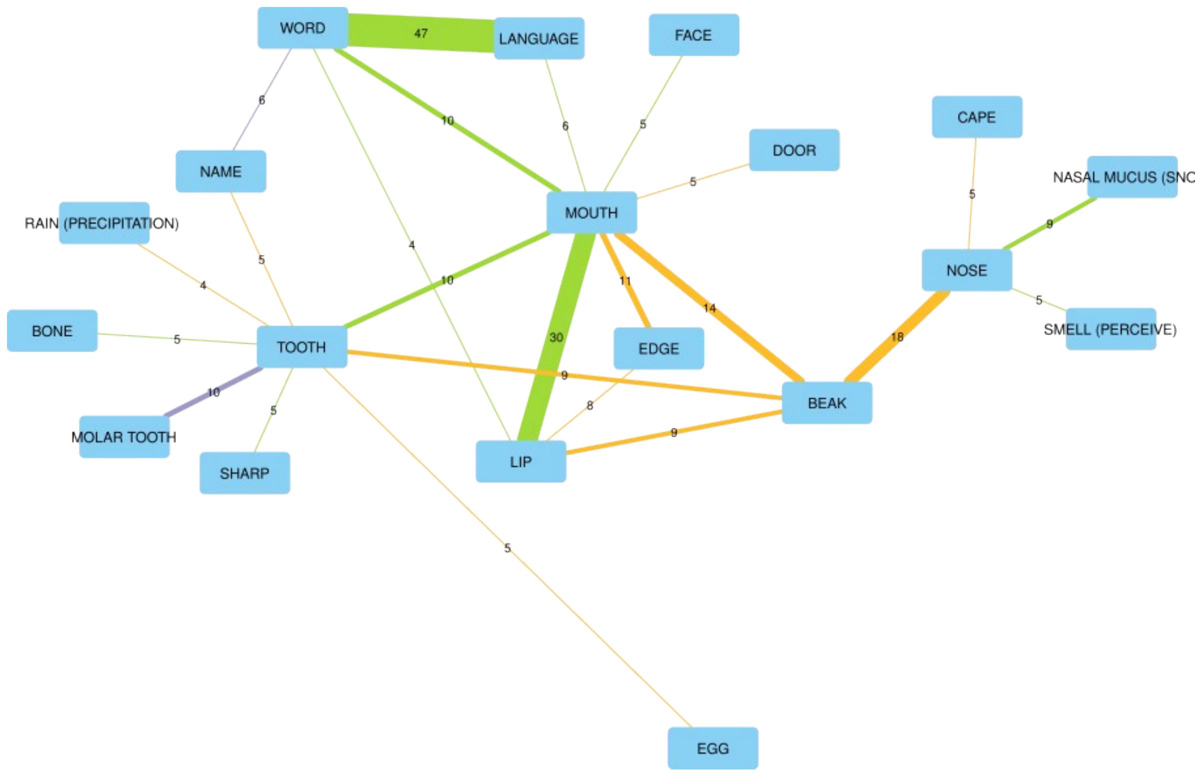

Figure 7: Full colexification network for the concept BEAK and its first and second degree neighbours (green indicated contiguity, orange similarity, and purple taxonomic inclusion; the edges' width and the number as label indicate the number of families in which a colexification occurs).

5 Discussion and Conclusion

While there is broad consensus among scholars that classical full colexification analyses yield robust results that can be used to draw conclusions on cross-linguistic semantic tendencies, we lack information on the robustness of partial affix colexification analyses. In this study, we have tried to close this gap by evaluating the potential of partial affix colexifiations for applications in lexical typology. In order to do so, we conducted two major analyses. Inferring large-scale partial affix colexification data from the recently published CLICS 4 database, we first conducted a detailed error analysis of 50 different language varieties. In a second step, we carried out a detailed annotation of the semantic-cognitive relations in the most frequently recurring partial and full colexification patterns, in order to investigate potential commonalities and differences in the semantic relations reflected by both types of colexification data.

Our error analysis clearly shows that partial affix colexification analysis suffer from a considerable amount of errors when applied to individual language varieties. At the same time, however, these errors can be easily excluded by concentrating only on those affix colexification patterns that recur frequently across different language families. Setting this threshold to five language families reduced the amount of direct algorithmic errors to 3%. Increasing the threshold further to ten language families further reduced the proportion of algorithmic errors to 1% and less. This shows that already in their current form in which an admittedly simple algorithm is used to identify specifica partial colexifications from cross-linguistic data, the approach seems to have the potential to provide interesting insights into the semantics underlying cross-linguistic patterns of word formation.

Our relation analysis shows that contiguity is by far the most frequent conceptual relation underlying affix colexification patterns. While the analysis of the conceptual relations underlying full colexification patterns also yields contiguity as the most frequently recurring relation, full colexification patterns show a smaller amount of contiguity relations and an increased amount of similarity relations (including cases of co-taxonomic similarity, which can be seen as a special case of similarity).

While the results for partial affix colexification fit nicely with previous hypotheses made in the literature, suggesting that derivative word formation is greatly shaped by contiguity or respectively metonymy (Bauer 2017; Janda 2011; Langacker 2009; Radden 2005; Jakobson & Halle1956[1971]), our results on full colexifications may seem in conflict with the traditional literature, which often sees metaphor as the key mechanism driving semantic change (Sweetser 1990). However, given that previous studies were not necessarily based on detailed counts, we consider it well possible that previous studies may have overestimated the role that metaphor plays in semantic change. This would also find confirmation in the study by Tjuka et al. (2024), who also found that body part vocabulary is rather shaped by contiguity than form or shape.

In any case, our study provides initial evidence that partial affix colexifications, inferred from large-scale cross-linguistic data with a rather simple automated approach, can in fact provide interesting evidence for additional studies and discussions in the growing field of lexical typology.

Supplementary Material

The supplementary material accompanying this study is available from the Open Science Framework and contains information on how to obtain the original CLICS 4

data used in this study, how to compute partial colexifications, and also contains instructions on how to analyze the annotated data. In short, all information, data, and code to replicate the studies reported here, should be available. The data can be found under the following link:
https://osf.io/z8sbc/?view_only=404adfe1be554347b3c2ab21f58c3214

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