Lexical Diachronic Semantic Maps
Mapping the evolution of time-related lexemes

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Abstract: This paper extends the scope of application of the semantic map model to diachronic lexical semantics. Combining a quantitative approach to large-scale synchronic polysemy data with a qualitative evaluation of the diachronic material in two text languages, ancient Egyptian and ancient Greek, it shows that weighted diachronic semantic maps can capture informative generalizations about the organization of the lexicon and its reshaping over time. The general methodology developed in the paper is illustrated with a case study of the semantic extension of time-related lexemes. This case study shows that the blend of tools well established in linguistic typology with proven methods of historical linguistics enables a principled approach to long-standing questions in the fields of diachronic semasiology and onomasiology.

Keywords: semantic maps, lexical typology, diachronic lexical semantics, co-expression, ancient Egyptian, ancient Greek

1. Introduction

This paper sets out to demonstrate that information on the paths of semantic extensions undergone by content words can fruitfully be integrated into semantic maps. This methodological challenge is addressed based on particular changes undergone by words belonging to the semantic field of time over the course of ancient Egyptian (henceforth AEg) and ancient Greek (henceforth AGr), two languages with rich diachronic material. This diachronic take on polysemic networks of content words extends the domain of application of the semantic map model and offers new perspectives for studying the question of meaning change in the field of diachronic lexical semantics (see Carling 2019: 20–21, Fritz 2019 and Geeraerts 2019 with references to previous literature).

The semantic map model has been used intensively during the last 20 years. The areas covered in the studies employing the model are impressively wide, but the majority of linguistic phenomena investigated pertain to the domain of grammar, e.g., tense, indefinite pronouns, modality, semantic roles, etc. (see Cysouw, Haspelmath & Malchukov 2010 and Georgakopoulos & Polis 2018 for an overview). However, starting with François (2008), who provided a blueprint for

constructing lexical semantic maps and showed that the model can be extended to lexical items, the field experienced a 'lexical turn'. Since the publication of François' paper, there has been an increase in the number of studies that focus on the lexicon and, in particular, on lexical associations of diverse notions, such as quality expressions (Perrin 2010), notions belonging to the domain of motion (Wälchli & Cysouw 2012, Reznikova & Vyrenkova 2015), the notion of emptiness (Rakhilina & Reznikova 2016), natural and spatial features (Youn et al. 2016; Georgakopoulos et al. 2016), and temperature terms (see various articles in the volume edited by Koptjevskaja-Tamm 2015).

What both lines of research share is the tendency to approach their question from a synchronic perspective. Research—relatively limited in comparison to synchronic studies—that has added the diachronic dimension has focused almost exclusively on the grammatical domain (Anderson 1982, Kemmer 1993, van der Auwera & Plungian 1998, Narrog 2010, Luján 2010, Eckhoff 2011, Narrog & van der Auwera 2011: 323–327, Georgakopoulos 2014, Luraghi 2014, Andrason 2016, Guardamagna 2016, Traugott 2016). While there is a significant number of studies on semantic change in the lexicon (e.g., Brown & Witkowski 1983, Viberg 1984, Sweetser 1990, Wilkins 1996, Evans & Wilkins 2000, Koch 2001, Allan 2008, Newman 2009, Vanhove 2008, Zalizniak et al. 2012, Zalizniak 2018, among others), semantic maps have been used almost exclusively from a synchronic point of view in lexical typology (see Urban 2011 for an exception), which does not come as a surprise given the complexity of historical relations between lexical meanings (Carling 2019: 203–377), as well as the limited access to diachronic data as compared to synchronic (see Hollmann 2009; Rakhilina & Reznikova 2016: 113). In order to overcome this limitation, Dellert (2016) applied causal inference to cross-linguistic databases of lexical associations and showed that one can successfully infer unidirectional trends of lexical change based on such associations.[1]

The present paper similarly takes up the challenge of studying general tendencies of evolution in the lexicon, but differs from previous studies inasmuch as (1) it resorts explicitly to the semantic map model and (2) it combines a quantitative synchronic dimension—which is based on information about colexification patterns[2] in many languages of the world—with a qualitative diachronic one—which relies on historical data from two languages with abundant diachronic material. Given the absence of any systematic study of the

[1] Computational detection of semantic shifts is an emerging field of research (see Kutuzov et al. 2018 for an overview of the approaches that rely on distributional methods).

[2] François coined the term 'colexification'—as opposed to Haspelmath's term 'multifunctionality' used for grammatical markers—to refer to the phenomenon in which a given language packages two functionally distinct meanings in the same lexical form in synchrony (François 2008: 170-171).

lexicon that takes diachrony into consideration in the semantic map tradition,[3] we tackle this problem with a case study of the semantic extension of time-related lexemes, such as *time*, *hour*, *summer, year*, etc. We selected the temporal domain for several reasons. First, time is central to human experience and temporal lexemes are consequently part of the basic vocabulary across languages (and, as such, frequently recorded in cross-linguistic datasets). Second, time occupied a salient position in antiquity and especially in both AEg and AGr cultures, as reflected, for example, in the sophisticated instruments for the measurement of time or in the wealth of religious and philosophical works relating to the concept of time (see Hannah 2009, Chantrain & Winand 2018). Third, rich polysemies are known to be associated with temporal concepts in the languages of the world, the motivation patterns of which have attracted attention in the literature, mainly within the paradigm of cognitive linguistics (e.g. Evans 2004, 2005, 2013, Marmaridou 2005, Piata 2018). Fourth, languages demonstrate a wide diversity in this domain: they differ, for instance, as to which pattern dominates in the conceptualization of time, the linear-based or the quantity-based. On the one hand, some languages manifest a conceptualization of time (more precisely of duration) as distance, as in English, in which it is more natural to use spatial linear expressions to talk about temporal concepts, e.g., *a long relationship*, *a long time* or AEg *m ꜣ.t ꜥ.t* '(lit.) a great moment' *vs. m ꜣ.t šrj.t/k.t* '(lit.) a small/short moment'. On the other hand, other languages show a conceptualization of duration as amounts of substance, as in Modern Greek, which uses primarily quantity based expressions, e.g., *meɣali sxesi, polis xronos* ('long relationship', lit. 'big relationship' and 'a lot of time', lit. 'much time', respectively; see Casasanto 2008: 70-72). Fifth, such conceptualizations are not necessarily stable, but can change over time. Such a change is reported in the course of Greek language history. Homeric Greek shows a double lexicalization of duration both in terms of linear distance and quantity, whereas in Modern Greek the quantity-based pattern prevails (Georgakopoulos & Piata 2012). In sum, the universal but also the culture-sensitive and language-specific character of the phenomena related to time, as well as the polysemic nature and the cross-

[3] Such studies are common outside the semantic map tradition. Similarly to the semantic map tradition, these studies often display graphically the interrelationships between meanings in the form of a radial network (Geeraerts 1997 and others). However, these networks differ from semantic maps both in terms of scope and underlying methodology. Radial networks typically visualize the semantic extension of a (limited number of) morpheme(s) (see the pioneering case of 'over' in Brugman & Lakoff 1988) and the connections between meanings are posited based on general cognitive principles (such as inferences, metaphors, metonymies, lambda-abstraction, etc.; see, e.g., Jurafksy 1996; Tyler & Evans 2001, Nikitina 2019). Semantic maps, on the other hand, usually take as a point of departure cross-linguistic data for a semantic field or set of functions and the relationships between senses are inferred based on patterns of co-expression. Hence this method is maximally empirical and inductive.

linguistic variation of terms used to describe these phenomena, make the temporal domain particularly interesting to research for a pilot study.

The structure of the paper is as follows. Section 2 introduces the theoretical premises of the semantic map model and discusses the diachronic dimension of semantic maps as well as issues pertaining to the visualization of historical changes. Section 3 provides a protocol for building semantic maps of lexical domains and applies this protocol to the semantic field of time. The result is a weighted synchronic semantic map inferred from recurrent colexification patterns. The purpose of Section 4 is to report on different semantic extensions of time-related lexemes in AEg and AGr, which will allow us to 'dynamicize' the synchronic semantic map. Section 5 summarizes the main results of the study and offers solutions to some of the problems outlined herein. Specifically, it suggests the use of mixed multigraphs, which—among other things—differentiate between edges that are inferred from synchronic co-expression patterns and edges resulting from diachronic analysis, as well as between diverse types of semantic shifts. This section concludes by identifying directions for future research.

2. Theoretical premises of the semantic map model

A semantic map is a way to visually represent the relationships between meanings based on patterns of co-expression across languages. Some linguists argue that these (similarity) relationships between meanings reflect (similarity) relationships in speakers' mental representations (see Croft 2001), while others consider them to be merely comparative concepts (Haspelmath 2018; see Haspelmath 2010 for the notion of comparative concepts; see also the debate between Cristofaro 2010 and Croft 2010). Semantic maps are plotted on the basis of cross-linguistic data and articulate implicational hypotheses that are considered valid as long as they are not contradicted by new empirical evidence (Anderson 1982, Haspelmath 1997, Croft 2001, Haspelmath 2003). Figure 1 is an abstract example of a semantic map, which consists of three nodes (or vertices) standing for meanings and of two lines (or edges) that represent relationships between these meanings.

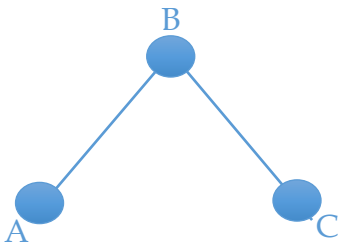


Figure 1. An abstract semantic map

The map predicts that, if a form has both meanings A and C, it must have meaning B as well, respecting the so-called Semantic Map Connectivity Hypothesis, which states that "any relevant language-specific and construction-specific category should map onto a CONNECTED REGION in conceptual space" (Croft 2001: 96). Following this principle, we are able to restrict the range of the possible polysemy patterns. In this example, a form may express A-B, B-C, or A-B-C, but not A-C, since it would infringe the connectivity hypothesis. The map remains stable as long as no language is found in which meanings A and C are expressed by a form without the presence of meaning B.

The method proceeds both onomasiologically and semasiologically (Gast 2009, van der Auwera 2013). Starting onomasiologically, it asks what the linguistic units are that express the concept(s) under investigation. In a second step, following a semasiological perspective, it seeks to identify the different meanings of these units. This list of meanings forms the basis for the construction of the map, but the list established intuitively is only tentative, since the distinction between meanings ultimately depends on cross-linguistic comparison. To refer again to the abstract semantic map in Figure 1, if the meanings A and B were respectively co-expressed (Hartmann et al. 2014) by the same form in all the languages of the dataset, one could not posit two nodes: a single node covering the vague meaning A-B would appear on the map. On the other hand, if at least one language of the dataset expressed A and B with different forms, the meanings A and B could be treated as distinct and represented by independent nodes (see further Haspelmath 2003).

Once the list of meanings is established, the nodes are connected using polysemic linguistic items as constraints. Every linguistic item should map onto a connected region of the map (see the connectivity hypothesis above) and the map should adhere to the economy principle (Regier et al. 2013: 92; Georgakopoulos & Polis 2018: 6–7), which states that an edge should be added between two meanings only if there is no connected subgraph of the map permitted while still respecting the connectivity hypothesis for a given polysemic item. To come back to Figure 1, meanings A and C could only be connected by an edge if a linguistic unit were to express A and C, but not B.

Turning to the diachronic dimension of semantic maps, what is important is that directionality of change is represented with arrows (technically called 'directed edges'). This graphic convention resembles the one employed in grammaticalization research (see Narrog & van der Auwera 2011). The arrows turn the synchronic map of Figure 1 into the dynamic map of

Figure ***2***. Following the terminology used in graph theory, we define a dynamic semantic map (a dysemap) as a set of vertices connected by edges that are allocated a direction.

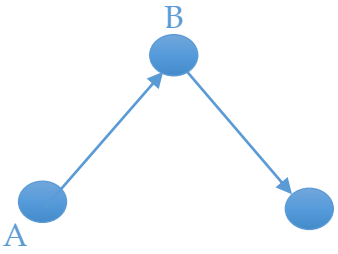


Figure 2. An abstract dynamic semantic map

This visualization shows that semantic extensions from A to B and from B to C are possible, but not from B to A or from C to B (again this generalization may have to be revised in the light of new diachronic evidence). The input that provides the basis for establishing directionalities in such diachronic maps can come directly from diachronic sources (see Section 4) or be inferred from synchronic sources. In the latter case, one can theorize about semantic change on the basis of ontological properties of meanings, e.g. whether a meaning is abstract or specific (see various grammaticalization studies in this respect; Croft 1991, Heine et al. 1991, Hopper & Traugott 2003). Another way to dynamicize synchronic data is to study the dependence of one meaning on another in a cross-linguistic sample. For example, in their study on grammaticalization patterns of allative markers, Rice & Kabata (2007) assume that, if meaning A has a total frequency of 40% in a given language sample, while meaning B has a total frequency of only 15%, and nearly all instances of meaning B occur in languages that also exhibit meaning A for the allative marker, then one can hypothesize that meaning A serves as a 'seed' for meaning B. Recently, Dellert (2016) suggested a similar but more principled method, resorting to causal inference, to predict dominant directionality in pathways of semantic change based on synchronic polysemic items.

The directed edges—that are added after the identification of source and target meanings—can represent different types of changes, e.g., changes that differ with respect to the range of meanings (extension or generalization *vs.* restriction or specialization) or changes resulting either from similarity of meaning (metaphor) or contiguity of meaning (metonymy) (van der Auwera 2013; Luraghi 2014). Figure 3 illustrates how diverse types of information can be integrated into the map. The connection between two independent ovals visualizes either metonymy or metaphor, whereas inclusion is used when a meaning A is a subset of meaning B, and meaning B is a superset of meaning A (hyper-/hyponymic relationships). In Figure 3, DEONTIC POSSIBILITY is a type-of/subset of PARTICIPANT-EXTERNAL POSSIBILITY.

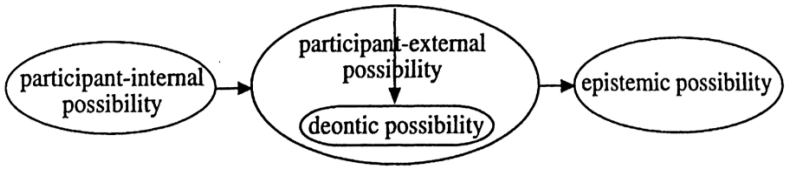


Figure 3. A mini-map of modal possibility (van der Auwera & Plungian 1998: 87, Figure 1)

As observed by Zwarts (2010), different type of edges are in fact sufficient for representing different types of relationships between meanings. For the sake of simplicity and uniformity, in Section 4 we resort to this solution for visualizing information about this type of semantic relationship in the synchronic map of time plotted in Section 3 below.

3. Towards a synchronic semantic map of the time domain

In this section, we provide a protocol for automatically plotting weighted semantic maps of a specific lexical semantic field based on large cross-linguistic datasets and we apply this protocol to the domain of time.

The first step involves choosing the particular concepts belonging to the domain investigated, in our case time. The basic principle underlying our choice has been the cross-linguistic availability of the concepts. To achieve cross-linguistic comparability, our point of departure was the three time-related concepts that appear in the 200-word Swadesh-list (Swadesh 1952), i.e. DAY/DAYTIME, NIGHT and YEAR. This method also ensures comparability with other studies that use cross-linguistic colexification data to measure semantic similarity between concepts (see, e.g., Youn et al. 2016).

The second step is to identify related concepts in the same semantic field. In order to achieve this goal, we resort to the richest resource in the field, i.e., the second version of the *Database of Cross-Linguistic Colexifications* (CLICS²; List et al. 2018a), an online resource that contains information about meaning associations in 1,220 language varieties. CLICS² aggregates 15 different datasets, including the *Intercontinental Dictionary Series* (Key & Comrie 2007), the *World Loanword Database* (Haspelmath & Tadmor 2009), and the NorthEuraLex (Dellert & Jäger 2017). Using the online interface (https://clics.clld.org), we visualize the clusters of concepts that include the three above-mentioned, time-related concepts of the Swadesh-list, namely the cluster DAY (NOT NIGHT) (see Fig. 4), the cluster DARKNESS, and the cluster SUMMER.

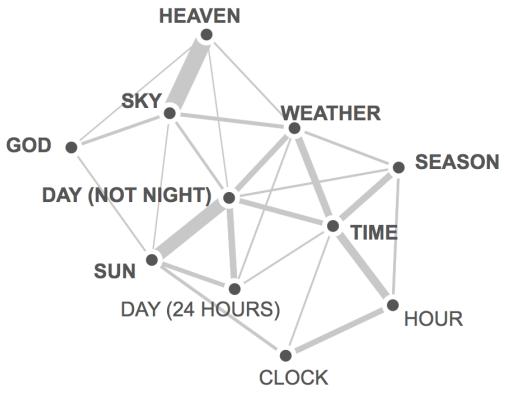


Figure 4. Cluster 'DAY (NOT NIGHT)' in CLICS²

With this approach, we are able to identify 30 different concepts belonging to the semantic field of time. These concepts are listed in Table 1.

Table 1. List of concepts linked to the meanings

Concepts in Swadesh list	**Concept(s) in CLICS²**	**Related concepts in CLICS² (cluster approach)**	**Number of concepts**
DAY/DAYTIME	DAY (NOT NIGHT), DAY (24 HOURS)	CLOCK; GOD; HEAVEN; HOUR; SEASON; SKY; SUN; TIME; WEATHER	11
NIGHT	NIGHT	AFTERNOON; BE LATE; BLACK; DARK; DARKNESS; DIRT; DIRTY; EVENING; LATE; OBSCURE; SECRET; SLOW; WEST	14
YEAR	YEAR	AGE; AUTUMN; SPRINGTIME; SUMMER	5

The third step is to collect all the lexical items from CLICS² that lexify at least one of these 30 concepts. In order to do so, we followed Forkel's cookbook[4] for CLICS² and extracted all the data in CSV format (with one word form and one meaning per line). Using a first Python script (α), we kept only the words that lexicalize one of the 30 concepts investigated, ending up with 21,095 individual word forms. Among these word forms, only 2,806 items (namely 13.3%) express more than one meaning and can accordingly be used as constraints in order to plot the semantic map of this semantic field. It is noticeable, however, that these items express a significant number of different meanings, with 921 different concepts in total. A second Python script (β) turns the list of word forms associated with meanings into a binary matrix, which is shown in Table 2.

4 Released as part of the CLICS² repository: https://github.com/clics/clics2/releases/tag/v1.1.1; cf. Forkel et al. 2018.

Table 2. Eight lexical items with associated meanings in the binary matrix

Source of constraint (= language)	**Constraint name (= lexical item)**	**Meaning 1 'DAY (NOT NIGHT)'**	**Meaning 2 'SOUR'**	**Meaning 3 'AFTERNOON'**	**Meaning 4 'AGE'**
Yagua	*hnda*	1	1	0	1
Hausa	*rana*	1	0	1	0
Ket	*iˀ*	1	0	1	0
Polci	*piidi*	1	0	1	0
Russian	*den*	1	0	1	0
Tlingit	*yakyee*	1	0	1	0
Khasi	*sngi*	1	0	0	0
Guaraní	*ara*	1	0	0	0

In this matrix, '1' represents an attested meaning and '0' a non-attested one. It shows, for example, that DAY (NOT NIGHT) and SOUR are colexified in one language (the form *hnda* in Yagua manifests this colexification pattern), whereas DAY (NOT NIGHT) and AFTERNOON are colexified in five languages of Table 2 (Hausa, Ket, Polci, Russian, and Tlingit).

In a fourth step, the lexical matrix is used as input for Angluin et al.'s (2010) algorithm, which has been implemented by Regier et al. (2013) for inferring semantic maps. This approximation algorithm, initially developed for inferring a social network from disease outbreaks in a population, solves a formally identical problem of inference: given a set of nodes (here meanings) and a set of constraints (here, lexical items), edges should be introduced one by one between the nodes in order of their utility—understood as the fact of satisfying a maximum number of constraints at the same time—until each constraint picks up a connected region of the graph (Regier et al. 2013: 94). As such, the algorithm adheres to the economy principle introduced in Section 2 and, according to the case studies of Regier et al. (2013), produces sensible semantic maps, i.e., maps that are at least as good as the manually plotted maps. In order to be able to take into account the frequency of the colexification, this algorithm has been slightly modified (Python script γ) in order to generate a weighted graph (the weight of each edge being equal to its 'utility'). The complete network for time-related meanings (time_full.gml), which takes the data from CLICS[2] as constraints for inferring a map, is made up of 921 nodes (i.e., meanings) connected by 1,605 edges. However, only 430 edges are supported by colexification patterns occurring in more than one language variety. Because of their low frequency in the language sample, which is likely due to cases of homonymy or language-specific historical scenarios, the initial graph has been filtered out for the sake of intelligibility, keeping only the meanings attested in at least two languages (which account for 71% of the underlying data).

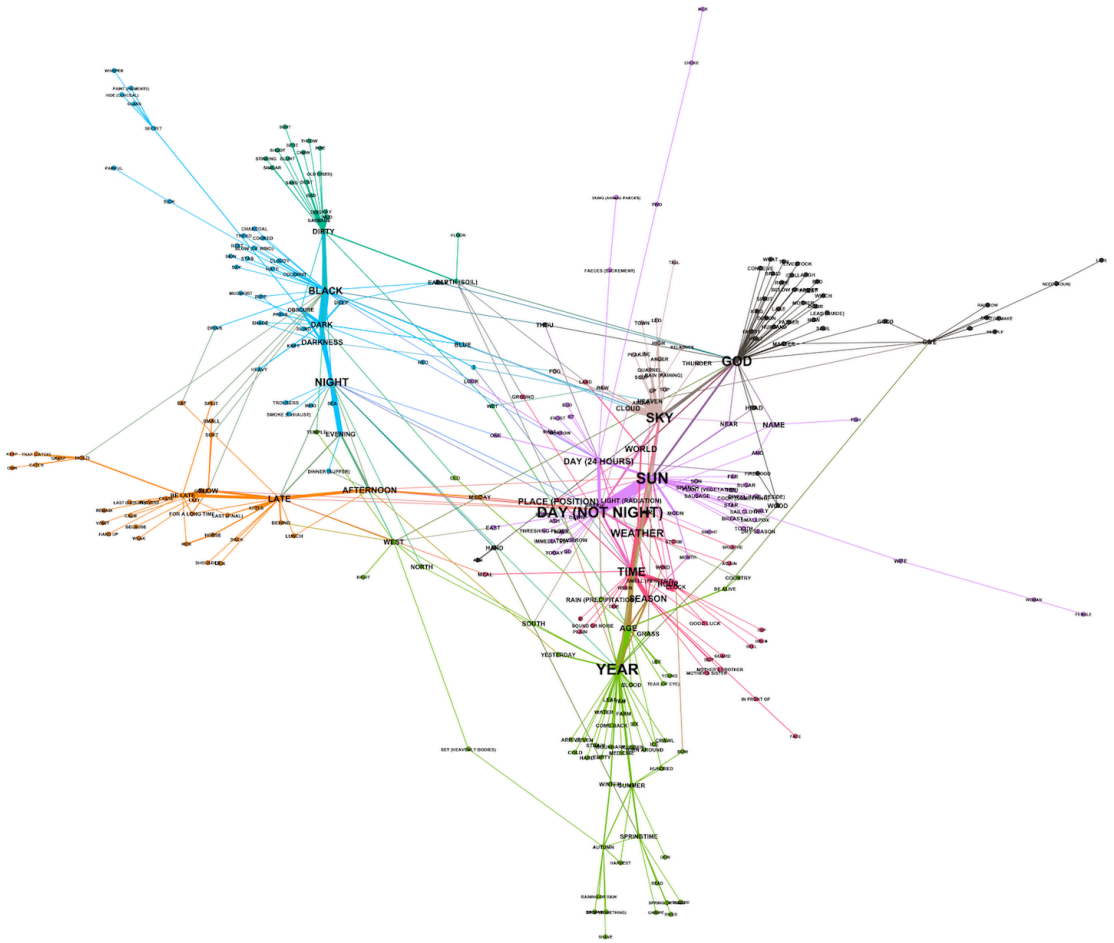


Figure 5. A semantic map of time-related concepts (weight = 2^{+})

Figure 5 is a visualization of this network with the Force Atlas algorithm of Gephi (https://gephi.org). The thickness of the edges is proportional to the frequency of occurrence of colexification patterns for any pair of meanings (cf. Cysouw, 2007; Youn et al., 2016): the more two concepts are colexified in the dataset, the thicker the edge is. For example, DAY (NOT NIGHT) and SUN are colexified more frequently than DAY (24 HOURS) and SUN; the former edge is therefore thicker than the latter. The size of the labels is based on Eigenvector centrality (a standard method of computing approximate importance of each node in the graph based on the importance of neighboring nodes): SEASON is less central than TIME which is less central than DAY (NOT NIGHT). Finally, modularity analysis is used in order to automatically identify communities, namely clusters of nodes that are more tightly connected to each other (see Newman 2006; Blondel et al. 2008). Eight main clusters are identified in the graph by different colors: orange (LATE/AFTERNOON), light-blue (NIGHT/BLACK), sea-green (DIRTY), black (GOD), light-brown (SKY), purple (DAY/SUN), pink (TIME/SEASON), green (YEAR).

Based on Figure 5, it can be seen that the graph consists of two main sub-graphs, the semantic field of NIGHT and associated meanings (DIRTY, BLACK, DARK, DARKNESS, EVENING, AFTERNOON, LATE) on the one hand, and the semantic field of DAY and related concepts on the other. Figure 6, in which we keep only the meanings connected by edges of weight 4 and more (goodness of fit = 55,2%), clearly shows that there are only a few solid articulation points between the sub-networks NIGHT and DAY: MIDDAY and AFTERNOON (between DAY (NOT NIGHT) and LATE/EVENING), and BLUE (between SKY and BLACK).

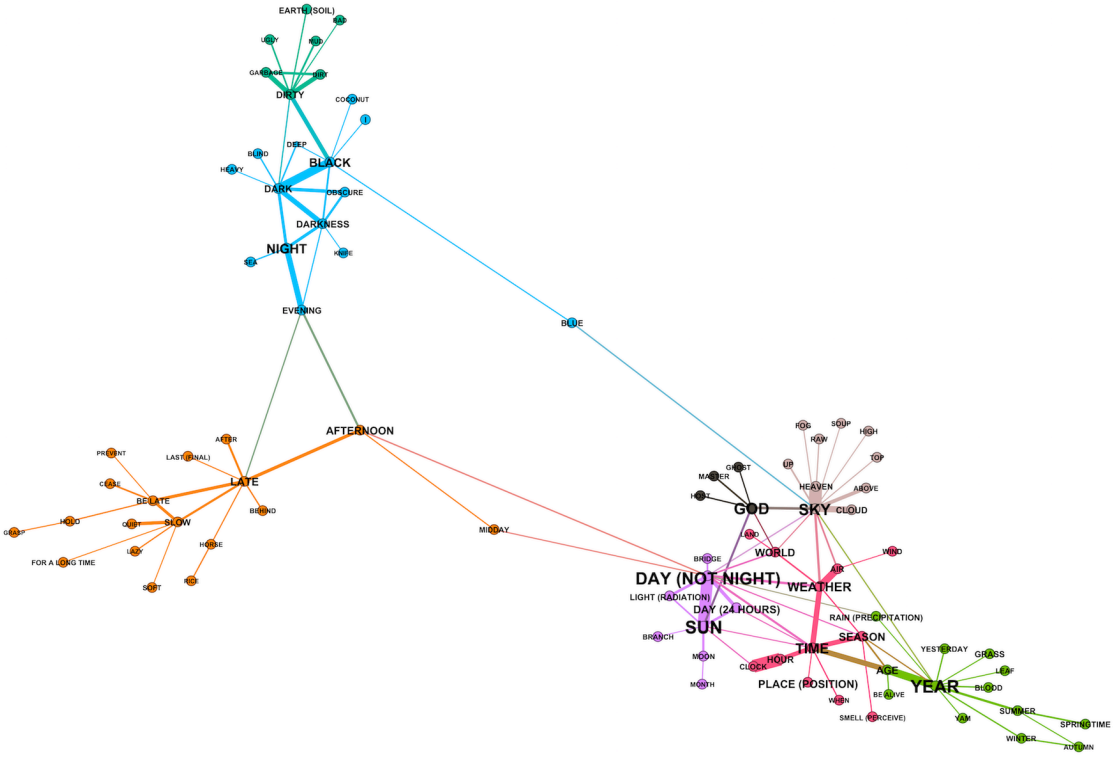


Figure 6. A semantic map of time-related concepts (weight = 4+)

Based on this preliminary result, namely the identification—in a purely inductive fashion—of two rather independent clusters (which correspond to intuitively coherent semantic fields), we decided to focus on the lager sub-network in the framework of the present study, i.e., the one that contains the concepts DAY and YEAR from the initial list and includes the more abstract notion of TIME.

In order to investigate directionality of change, 18 substantival meanings (i.e., meanings that are typically represented by nouns) that are connected in this sub-network of the map in at least 12 different language varieties were kept (Figure 7): AGE, AIR, CLOCK, CLOUD, DAY (24 HOURS), DAY (NOT NIGHT), GOD, HEAVEN, HOUR, LIGHT, MOON, SEASON, SKY, SUMMER, SUN, TIME, WEATHER, YEAR. We acknowledge that removing infrequent edges results in missing associations that are interesting from a typological point of view, since the map of Figure 7 covers

only 40% of the colexification patterns attested in this semantic field, but full coverage is not the point here. The goal is to select (in a principled way) meanings that could display interesting diachronic colexification patterns: the more often a meaning is colexified in the languages of the world, the more likely one is to identify colexification patterns for this meaning in the language that is the focus of the diachronic investigation.

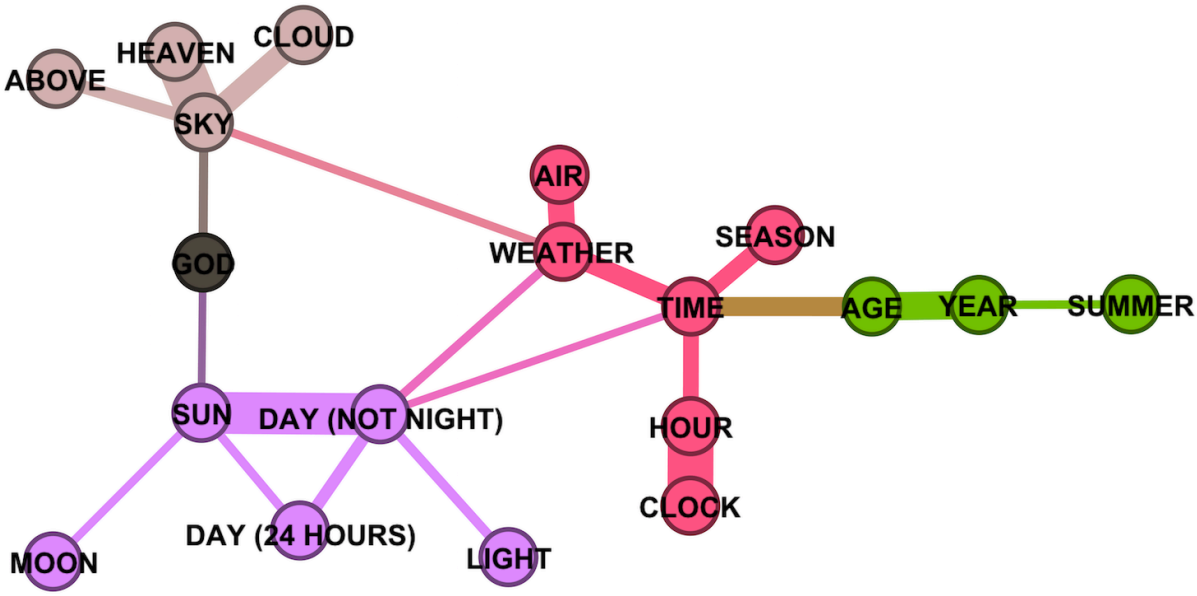


Figure 7. A semantic map of time-related concepts (weight = 12+)

Furthermore we compensate for this (temporary) loss of information when zooming in on the diachronic material from AEg and AGr (Section 4): rarer colexification patterns are reintegrated so as to situate the results of our diachronic inquiry within a more complex typological picture.

The four steps of the protocol followed so far, which led to the construction of a synchronic semantic map of time-related concepts, can be replicated for any semantic field. In the present study, these steps constitute the typological foundation for the diachronic investigation conducted in Section 4, which describes the pool of data we relied on in order to identify semantic shifts in this area of the lexicon.

4. Dynamicizing the synchronic map of time

In this section, we enrich the synchronic semantic map of time-related meanings with information about pathways of change. CLICS^2 does not provide information regarding possible or attested evolutionary paths and, as a consequence, we resort to other solutions.

Several studies rely on synchronic co-expression (what François terms strict colexification in the case of lexical items) to infer directionalities of change (e.g.,

Münch & Dellert 2015, Dellert 2016, Urban 2011, 2012). This methodological choice mirrors the view that polysemy is "the synchronic reflection of diachronic semantic change" (Blank 1997: 406–410; Geeraerts 1997: 6; see also Sweetser 1990: 9). This "polysemous view of semantic change" (Evans 1992: 476, Wilkins 1996: 269–271, Evans & Wilkins 2000: 549ff.) has been a standard assumption in cognitive-oriented studies (see also the 'Overlap Model' in Heine 1993: 48ff.). We also commit ourselves to this claim, but, given that the validity of inferences about semantic change based on polysemy patterns has to be assessed systematically against diachronic data anyway, in the current study, we report directly on diachronic semantic developments of individual lexemes that are actually attested in historical corpora. First, we turn to the main typological resource in the field, namely the *Catalogue of semantic shifts* (Section 4.1), and then explore data provided by AEg and AGr (Section 4.2).

4.1. Catalogue of semantic shifts

The *Catalogue of semantic shifts* is a project that aims to identify recurring cross-linguistic semantic shifts. In this framework, the term 'semantic shift' refers to the "relation of cognitive proximity between two linguistic meanings" and, depending on the nature of this relation, five types of realizations of semantic shifts are distinguished: synchronic polysemy, borrowing, cognates, morphological derivation, and diachronic semantic evolution (Zalizniak 2008, 2018, Zalizniak et al. 2012). All semantic shifts identified in the framework of the *Catalogue of semantic shifts* have been collected in the form of a database (*Database of semantic shifts in the languages of the world*; DatSemShift 2.0; http://datsemshift.ru). Examples (i)–(v) illustrate the five different types represented in the database:

i. *Meanings*: tree *(source)*—forest (*target*) (ID: 600); *Example*: dar; *Language*: Aghul; *Realization Type*: synchronic polysemy
ii. *Meanings*: count *(source)* → speech (*target*) (ID: 11); *Forms*: ratio → Rede; *Languages*: Latin (*donor*) → German (*target*); *Realization Type:* borrowing
iii. *Meanings*: doll *(source)*—nymph, chrysalis (*target*) (ID: 927); *Example*: kukla; *Language pair*: Russian —Czech; *Realization Type*: cognate
iv. *Meanings*: arc *(source)* → rainbow (*target*) (ID: 393); *Example*: Bogen → Regenbogen; *Language*: German; *Realization Type:* morphological derivation
v. *Meanings*: to catch *(source)* → to hunt (*target*) (ID: 415); *Forms*: capto → cacciare; *Languages*: Latin → Italian; *Realization Type:* diachronic semantic evolution

(all examples come from the DatSemShift)

In the database, all types of realizations except for synchronic polysemy can—but do not necessarily (see ex. iii)—receive a vector denoting directionality of change. Those instances in which the pair of meanings belongs to more than one language, i.e. cognates and borrowed words, were excluded from our study, since our focus is on diachronic developments occurring within the same language.

Despite the fact that synchronic relationships of word-formation may hint at likely directions of diachronic semantic changes (Urban 2011, Zalizniak 2018), we decided to exclude cases resulting from morphological derivation. Indeed, the connections between meanings in the maps of Figures 5–7 are not based on colexifications of this kind, and the integration of morphological derivatives would lead to unwanted infringements of the connectivity hypothesis due to the combination of morphemes that they imply.[5]

This means that we are only interested in cases of shifts that fall under the label '(diachronic) semantic evolution' in the DatSemShift 2.0. To refer to this capacity of a single lexeme to link two related meanings across different diachronic stages, we extend François' term 'colexification' and call this general process 'diachronic colexification'. Restricting our scope to such cases of diachronic colexification, the DatSemShift 2.0 reveals only a small handful of examples for the domain of time investigated here:

vi. *Meanings*: weather *(source)* → bad weather (*target*) (ID: 3084); *Forms*: tempestas (Latin) → tempesta (Italian)

vii. *Meanings*: spring *(source)* → summer (*target*) (ID: 3089); *Forms*: ver (Latin) → vară (Romanian)

viii. *Meanings*: mountain *(source)* → cloud (*target*) (ID: 2739); clúd (Old English = 'mass of rock, hill') > cloud (English)

These three Indo-European examples are admittedly of limited bearing for the purpose of the present paper, but point to the fact that semantic shifts are of different kinds, follow different mechanisms and are caused by various forces (e.g. Bréal 1964 [¹1897], Bloomfield 1933, Ullmann 1957, McMahon 1994: 178–184, Blank 1997, 1999, Geeraerts 1997, Győri 2002, Grzega 2004): (vi) is an example of reduction (or specialization, or narrowing), with the Latin lexeme *tempestas* that was already able to express 'bad weather' in Latin (Lewis & Short 1962 [¹1879]), while (viii) is a case of extension (or generalization, or broadening), with a metaphorical extension motivated by similarity of shapes. These different scenarios of diachronic colexification will have to be acknowledged when integrating the results in the dynamicized semantic map (Section 4.3).

[5] See Münch & Dellert (2015) 'This result supports the intuition that the shifts attainable by derivation differ in a substantial way from the shifts attainable by plausible sequences of shifts along paths defined by strict colexification.' (see also Georgakopoulos et al. 2016).

4.2. Time-related lexemes in Ancient Egyptian and Ancient Greek

AEg, which represents an independent branch of the Afroasiatic phylum (Loprieno 1995; Grossman & Richter 2014), and AGr, an Indo-European language, constitute the empirical basis of this study. The data for AEg cover nearly 4,000 years, from the 3rd millennium BCE until its obsolescence sometime after the 1st millennium CE, when all of its speakers eventually shifted to Arabic. It is standardly divided into five major stages: Old Egyptian (2800–2000 BCE), Middle Egyptian (2000–1450 BCE), Late Egyptian (1450–700 BCE), Demotic (700 BCE–450 CE), and Coptic (approx. 300–1450 CE), which is still in use as the liturgical language of the Christians of Egypt. In this study, we group Old with Middle Egyptian and Late Egyptian with Demotic[6]. The data for AGr span from Homeric Greek (8th c. BCE) through Classical Greek (5th–3rd c. BCE) to the end of the Hellenistic–Roman period (4th c. CE). As such, the diachronic investigation for both languages includes three different diachronic stages.

To identify diachronic colexifications in the two languages, we rely on the following method. First, we provide definitions for the 18 concepts obtained through the method described in Section 3 in order to ensure the comparability of the phenomena analysed. We relied on the definition contained in the Concepticon (http://concepticon.clld.org), which is a resource that links concept labels from different concept lists to concept sets. What is important for our purposes is that (a) CLICS² is one of the lists included in Concepticon[7] and (b) the concept sets are given a unique definition, which can be applied to our material. For example, the concept set AGE is defined as 'the period of time that a person, animal or plant has lived or is expected to live' and this specification was used in order to find the relevant lexemes in AEg and AGr. It should be noted that we adjusted those definitions that were applicable only to modern societies. For instance, while the concept HOUR, as a division of the day and night into equal time-spans, is applicable to the AEg and AGr cultures, its definition as 'a time period of sixty minutes' is not relevant.

Second, using dictionaries, we give translations for the 18 concepts (Table 3). The metalanguages used are English and German both for AEg (http://aaew.bbaw.de/tla/index.html, Hannig 2000) and AGr (Passow 1841, Chantraine 1968, Liddell-Scott 1996; Montanari 2015). Note that the translations provided correspond to the earliest stage of these languages, Earlier Egyptian (2800–1400 BCE) and Homeric Greek (8th c. BCE) respectively (the only exception

6 This grouping is the norm in Egyptological linguistics: Old and Middle Egyptian form 'Earlier Egyptian', while Late Egyptian and Demotic belong to 'Later Egyptian.' For a brief linguistic characterization of these two main phases of Ancient Egyptian, see Loprieno (1995: 5–8).

7 Note that the Concepticon was created after CLICS² and, as a result, the elicitation of the data in CLICS² precedes the definitions in CONCEPTICON. This means that these definitions do not necessarily comply fully with the content of the concepts as elicited. However, the advantage of this methodological decision is that it makes the process replicable.

being the AGr lexeme *kairós*, which is not attested in Homer), and that we tracked the semasiological evolution of these lexemes in the history of AEg and AGr. An alternate (and complementary) method, which has not been pursued here, would be to look at the translation of these concepts in later phases and to study their etymology and evolution. Consider, for instance, the AIR and CLOUD meanings in AEg, which can be expressed by the compound *sṯz.w-šw* (literally 'what the god Shu lifts up'; *Wb*. 4, 361,8-14). This compound is not included in Table 3, because it is not attested before the beginning of the New Kingdom. Similarly, in AGr the word *hṓra/ē* occurs with the meaning 'hour' only in the Hellenistic–Roman period and is consequently not included as a lexification of HOUR in Table 3. Finally, note that the empty cells in Table 3 designate the absence of a dedicated lexeme for a concept in this first documented stage of the language (see for instance the concept CLOCK).

Table 3. Main concepts with their definitions and translations in AEg and AGr

Concept	**Definition in the Concepticon**	**Adjusted definition**	**Lexeme in AEg**	**Lexeme in AGr**
AGE	The period of time that a person, animal or plant has lived or is expected to live.	-	*jꜣw(.t)* '(old) age' *ꜥḥꜥw* '(life)time, age'	*hēlikíē* 'age, of the same age'
AIR	A predominantly mechanical mixture of a variety of individual gases forming the Earth's enveloping atmosphere.	Breathable substance on Earth.	*ṯꜣw* 'air, wind, breath'	*aithḗr* 'air, clear air, sky'
CLOCK	An instrument used to measure or keep track of time.	-	_[8]	-
CLOUD	Suspensions of minute water droplets or ice crystals produced by the condensation of water vapor.	Visible mass of minute water droplets in the sky.	*(j)gp* '(rain) cloud' *šnꜥ* '(storm) cloud)' *ḳrj* 'cloud'	*aḗr* 'mist, cloud' *néphos* 'mist, cloud, swarm' *nephélē* 'mist, cloud'
DAY (24 HOURS)	A period of time lasting 24 hours.	The period between two	*hrw* 'daylight, day'	*êmar* 'daylight, day'

[8] All the words referring to instruments for measuring time (*mrḫ.t*, *sṯꜣ.t*, *(wn)šb.t*) are attested in texts of the New Kingdom onwards (Salmas 2013a, 2014; Bickel & Gautschy 2014). These lexemes are not directly related to other concepts on the map—they are linked to the notion of knowing (*mrḫ.t*) and to the course of the Sun in the sky (*sṯꜣ.t*)—, but note that the logogram for *(wn)šb.t* 'clepsydra' is used as a cryptographic spelling for 'hour' in texts from the Ptolemaic Period (cf. Kurth 2004: 650–652).

		sunrises.	*sw* 'day (in date)	*ēős* 'dawn, morning, day, east'
DAY (NOT NIGHT)	The period between sunrise and sunset where one enjoys daylight.	-	*hrw* 'daylight, day'	*êmar* 'daylight, day' *ēős* 'dawn, morning, day, east'
GOD	A supernatural, typically immortal, being with superior powers.	-	*nṯr* 'god'	*theós* 'god' *athánatoi* 'the gods', *daímōn* 'god'
HEAVEN	Outer space visible from the Earth's surface, infinitely extending above us and limited by the horizon.	-	*p.t* 'sky, heaven'	*ouranós* 'sky, heaven' *aithḗr* 'air, clear air, sky'
HOUR	A time period of 60 minutes; one twenty-fourth of a day.	One twelfth of the night or daytime.	*wnw.t* 'hour, moment'	-
LIGHT	Electromagnetic radiation that is capable of causing a visual sensation.	Radiation, typically coming from the Sun or lamps, which is responsible for the sense of sight.	*ꜥnḏ.w* '(sun)light, dawn' *sšp* 'light' *šw* '(sun)light, sun'	*pháos* 'sun(light), artificial light, the eyes (in plural), safety' *augḗ* 'sun(light), splendor'
MOON		Main astronomical body visible from Earth at night.	*jꜣḥ* 'moon'	*selḗnē* 'moon'
SEASON	One of the four equal periods into which the year is divided by the equinoxes and solstices, resulting from the apparent movement of the Sun north and south of the equator during the course of the Earth's orbit around it. (...)	A period of the year marked by changes in natural phenomena (such as weather and amount of daylight).	*tr* 'season, time, moment'	*hṓrē* 'season, time, moment' *kairós* 'fitting time, time, season, important part of the body' (post-homeric lexeme)
SKY	The part of the Earth's atmosphere and space outside it that is visible from Earth's surface. During the day it is perceived as blue, and at	The mass of air that lies above the surface of the Earth, perceived as	*p.t* 'sky, heaven'	*aithḗr* 'air, clear air, sky' *ouranós* 'sky, heaven'

	night as black.	blue during the day, and at night as black.		
SUMMER	Traditionally the second of the four seasons regarded as being from June 21 to September 20 (or just June, July and August) in the Northern Hemisphere and from December 21 to March 20 (or just December, January and February) in the Southern Hemisphere.	The hottest period of the year.	*šmw* 'summer, harvest'	*théros* 'summer'
SUN	The particular star at the centre of our solar system, from which the Earth gets light and heat.	The star that is the source of light and heat for the Earth.	jtn 'sun(disk)' *rʿw* 'sun' *šw* '(sun)light, sun'	*hḗlios* or *ēélios* 'sun, sunlight, east'
TIME	The dimension of the physical universe, which, at a given place, orders the sequence of events.	(a) The continuum of experience in which events pass from the future through the present to the past; (b) The duration of an interval; (c) The moment in time when something happens.	*ꜣ.t* 'moment, time' *nw* 'moment, time' *rr* 'time' *tr* 'season, time, moment' *hꜣw* 'era, time, proximity' *rk* 'epoch, era, time' *ʿḥʿw* '(life)time, age'[9]	*khrónos* 'time, duration' *hṓrē* 'season, time, moment' *kairós* 'fitting time, time, season, important part of the body' (post-homeric lexeme)
WEATHER[10]	The day-to-day meteorological conditions, especially temperature, cloudiness, and rainfall, affecting a		-	-

9 None of these lexemes has originally the general sense 'time' as its basic meaning (Salmas 2017, p. 11). They express more specific senses, such as 'moment', 'period', 'epoch' and refer to time only in particular collocations.

10 Note that in both AEg and AGr there are many specific terms for referring to 'bad weather', 'storm' and 'tempest' (AEg: s *nšn, (ḫꜣ)ḫꜣ.tj, ḫꜣp.t, sšn, šnj.t, šnʿ, ḳrr, ḏʿ*; AGr: *thúella*, *kheîma*) or 'good weather' (AEg: *ḥtp.w*; AGr: *aíthrē̄*), but no generic cover-term for 'weather'.

	specific place.			
YEAR	The time it takes the Earth to complete one revolution of the Sun (between 365.24 and 365.26 days depending on the point of reference).	The cycle of seasons that repeats itself.	*rnp.t* 'year'	*étos* 'year', *eniautós* 'year'

In the third step, we proceed semasiologically by listing the different meanings of the lexemes identified in the previous step. This part of the process is dictionary-based and applied to the three diachronic stages of AEg and AGr respectively. In addition to dictionaries, we consulted resources of the object languages, which provided information about the lexemes under investigation, e.g., Buck's (1949) *Dictionary of Selected Synonyms in the Principal Indo-European Languages* or Hornung's (1961), Spalinger's (1992), Salmas' (2013b, 2017) and Chantrain's (Fthc.) studies of various time related lexemes in AEg. The final step involves collecting text examples of each of the meanings for both languages, mainly using searchable electronic corpora, i.e. the *Thesaurus Linguae Aegyptiae* (http://aaew.bbaw.de/tla/), *Ramses Online* (http://ramses.ulg.ac.be), and the *Coptic Scriptorium* (http://copticscriptorium.org) for AEg, and the Perseus digital library (http://www.perseus.tufts.edu/hopper/) and *Thesaurus Linguae Graecae* (http://stephanus.tlg.uci.edu/) for AGr.

The result of this protocol is a binary lexical matrix with the AEg and AGr lexical items identified in Table 3 in the *y*-axis (one line per diachronic stage) and the 18 basic concepts, plus the additional meanings identified during the semasiological analysis, in the *x*-axis. Table 4 is an illustrative excerpt of this matrix for two lexemes.

Table 4. Binary matrix for two lexical items with associated meanings in different diachronic stages

Lexeme	Diachronic Stage	Meaning 1 'moment'	Meaning 2 'time'	Meaning 3 'day (not night)'	Meaning 4 'hour'
nw	1_Ealier Egyptian	1	-	-	-
	2_LateEgyptian/Dem.	1	1	-	-
	3_Coptic	1	1	1	1
hṓra/ē	1_Homeric Greek	1	1	-	-
	2_Classical Greek	1	1	1	-
	3_ Hellenistic–Roman	1	1	1	1

4.3. The semantic extension of time-related lexemes in Ancient Egyptian and Ancient Greek

In this section, we explore the AEg and AGr diachronic material in order to enrich the synchronic semantic map in Fig. 8[11] with information about pathways of change. The map in Fig. 8 is based on polysemy patterns of lexical meanings[12] attested in at least six languages[13] (weight = 6+; cf. Section 3).

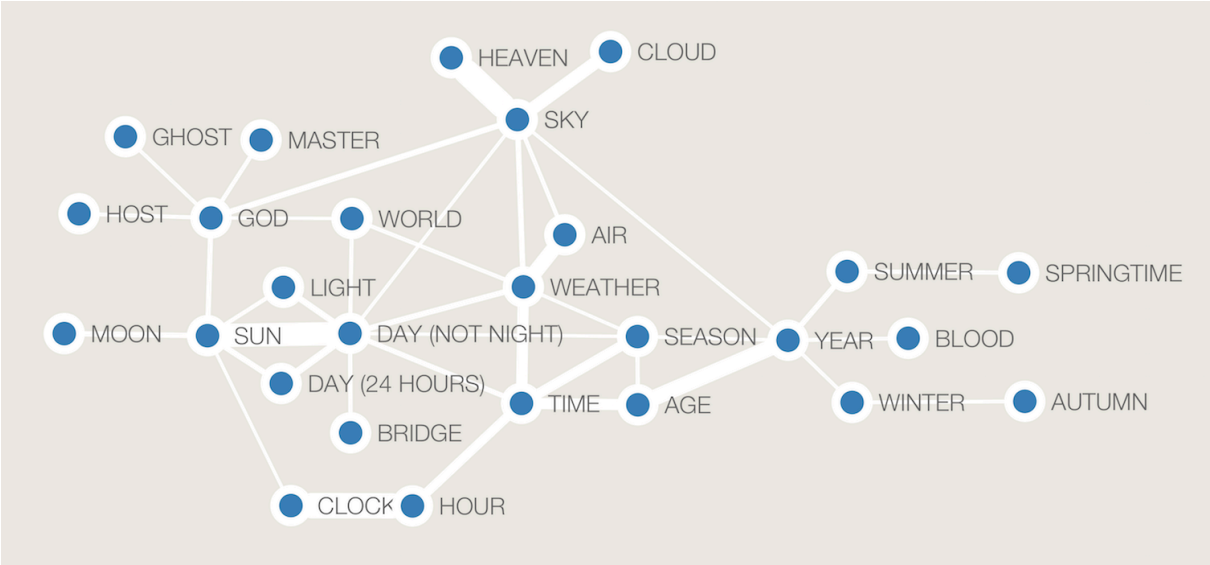


Figure 8. A semantic map of time-related concepts (weight = 6+)

We first provide evidence for semantic evolution between meanings that are represented in this graph (§4.3.1 and §4.3.2), before turning to extensions to meanings that do not appear in Fig. 8, either because they are filtered out due to their low cross-linguistic frequency or because they are not part of the basic concept sets of CLICS[2]. Finally, an unexpected evolution from the TEMPORAL to the SPATIAL domain is discussed in order to illustrate the role of language-specific factors in historical semantics (§4.3.3).

The data are organized from the more general—investigating pathways of change between frequently colexified meanings—to the more specific. We do not intend to discuss here the complete list of meaning extensions in this semantic domain for each lexeme listed in Table 2: rather we focus on case studies that

[11] The maps in Fig. 8–12 are produced with Cytoscape (https://cytoscape.org), an open source software platform for complex network analysis and visualization originally designed for biological research.

[12] The following seven meanings, which did not belong to the ontological category THING/PERSON in the classification of Concepticon, were deleted manually from the map: ABOVE, BE ALIVE, RAW, SMELL (PERCEIVE), UP, WHEN.

[13] This threshold allows us to reintroduce enough typological diversity (compare with the map in Fig. 7) without visualizing spurious correlations resulting from homonymy or language specific colexification patterns.

illustrate the main methodological issues when dynamicizing a synchronic semantic map of content words. Similarly, we do not investigate meaning loss[14] and (rate of) lexical replacements (Pagel et al. 2007, Vejdemo & Hörberg 2010): such information cannot be used as argument for dynamicizing a synchronic semantic map.

Note in this respect that the meaning of several lexemes is very stable over time. Such meanings can consequently not be used for the purpose of enriching the map with directionalities of change. A case in point is the AGr *étos* 'year', which remains remarkably stable over the centuries up until Modern Greek. Similarly, AEg *rnp.t* 'year' (*Wb*. 2, 429–432,5), which is derived from the root *rnp* 'to become young', is attested with this meaning from the earliest records onwards and does not undergo any significant semantic change down to Coptic, where it is realized as *rompe* 'year' (*CD* 296*b*–297*a*).

4.3.1. Semantic extensions to and from TIME

The rather abstract meaning TIME is an important node of the graph with no less than five edges connecting it directly to other meanings. In this section, we describe the semantic extension of a series of AEg and AGr lexemes that may express this meaning. In Homeric Greek, *hṓra*, which goes back to a proto-Indo-European root **Hieh,-r-, Hioh,-r-* 'year' (Beekes 2010: 1681; see also Chantraine 1968, Pokorny 2007), is the lexeme for referring generically to the period in which a year is divided according to the weather conditions, namely to SEASON. This meaning is illustrated in (1):

1.

hóssá	*te*	*phúlla*	*kaì*	*ánthea*
REL.NOM.PL.N	PTCL	leaf(N):NOM.PL	CONJ	flower(N):NOM.PL

gígnetai	***hṓrēi***
become:PRS.3SG	**season(F):DAT.SG**

'as are the leaves and the flowers in their **season**'[15] (Homer, *Iliad* 2.468; 8th c. BCE)

Homer makes reference to three *hôrai* (seasons): spring (*éaros hṓrē* 'spring season', *Iliad* 6.148), winter (*hṓrēi kheimeríēi* 'in wintry season', *Odyssey* 5.485) and summer/autumn (*hṓrai epibríseian* 'in rainy seasons', *Odyssey* 24.344; see also *théreos* […] *hṓrēi* 'in the season of heat', Hesiod, *Opera et dies* 584). It is

[14] For a taxonomy of five types of structural innovations in the lexicon, see François (under review).

[15] For the translations of the AGr passages, we rely on those provided by the Perseus Digital Library Project (http://www.perseus.tufts.edu/hopper/). The translations of AEg are our own.

noteworthy that *hôrai* became personified as distinct goddesses of season and evidence for the existence of this personification can be found in Homer and Hesiod (see Chantraine 1968: 1303, Bremer 2013).

At the same stage, *hṓra* is also used to designate a discrete interval of time (MOMENT meaning; see (2)), which is appropriate for something. This meaning is well attested in Homer who mentions an *hṓra* to sleep (*heúdein*; *Odyssey* 11.331), an *hṓra* for a meal (*deîpnon*; *Odyssey* 17.176), etc.

2.

óphra	*Poseidáōni*	*kaì*	*állois*	*athanátoisin*
CONJ	Poseidon(M):DAT	CONJ	other:DAT.PL	immortal:DAT.PL

speísantes	*koítoio*	*medṓmetha:*
pour_libation:PTCP.AOR.NOM.PL.M	bed(M):GEN.SG	think_of:PRS.1PL.SBJV.M/P

toîo	*gàr*	***hṓrē***
DEM.GEN.SG	PTCL	**time(F):NOM.SG**

'that when we have poured libations to Poseidon and the other immortals, we may bethink us of sleep; for it is the **time** thereto' (Homer, *Odyssey* 3.333-334; 8th c. BCE)

Occasionally, the TIME/MOMENT meaning is elaborated in terms of deictic motion (cf. Evans, 2004: 71, for the English lexeme *time*),[16] as illustrated in the Classical Greek example (3) from Pindar:

3.

makrá	*moi*	*neîsthai*	*kat'*	*amaksitón:*
long:NOM.SG.F	1SG.DAT	go:PRS.INF.M/P	DIR.INFR	highway:ACC.SG.M

hṓra	*gàr*	*sunáptei*
time(F):NOM.SG	PTCL	join.together:PRS.3SG

'Returning home by highway is too long; for **time** is approaching'
(Pindar, *Pythian* 4.247; 5th c. BCE)

The same SEASON-MOMENT association is also observed in the post-Homeric lexeme *kairós*, the prototypical meaning of which can be described as "the time or place at which, or degree in which, something is appropriate" (Heath 1989: 30).

After Homer, the SEASON and MOMENT meanings are still present, but *hṓra* expands the range of contexts in which it can occur and develops new meanings.

[16] SEASON can also be elaborated by deictic motion, as in *epḗluthon hôraì* 'the seasons came round again' (Homer, *Odyssey* 2.107).

One of the most striking semantic extensions, which begins in Classical Greek, is the extension from TIME/MOMENT to HOUR. The first indirect piece of evidence indicating that *hṓra* conveyed the meaning HOUR probably as early as the 4th c. BCE comes from a passage by Diogenes Laertius (3rd c. CE), who refers to a comment by Diogenes of Sinope (approx. 404-323 BCE) on the time-reckoning device *hōroskopeîon* (lit. a device for looking at the time; see Hannah 2009: 70):

4.

ho	*goûn*	*Diogénēs*	*pròs*	*tòn*	*epideiknúnta*
ART.NOM.SG.M	PTCL	Diogenes:NOM	LAT	ART.ACC.SG.M	exhibit:PRS.PTCP.ACC.SG.M

autôi	*hōroskopeîon,*	*khrḗsimon*	*éphē*	*tò*
DEM.DAT.SG.M	clock(N):ACC.SG	useful:ACC.SG.N	say:AOR.3SG	ART.ACC.SG.N

érgon	*pròs*	*tó*	*mὲ*	*husterêsai*	*deípnou*
PTCL	LAT	ART.ACC.SG.N	NEG	come.later:AOR.INF	meal(N):GEN.SG

'Anyhow, when somebody showed Diogenes a clock, he pronounced it a useful instrument to save one from being late for dinner.' (Diogenes Laertius, *Lives of Eminent Philosophers 6.9*/ 3rd c. CE)

Given this context, it seems a reasonable conclusion that the device Diogenes is being shown is not used to measure seasons, but instead the times of the day. In example (5) from New Testament, *hṓra* prompts an HOUR reading.

5.

oukhì	***dṓdeka***	***hôraì***	*eisin*	*tês*	*hēméras;*
NEG	**twelve**	**hour(F):NOM.PL**	be.PRS.3PL	ART.GEN.SG.F	day(F):GEN.SG

'Aren't there **twelve hours** of daylight?' (New Testament, John 11:9; 1st c. CE)

The HOUR meaning is derived metonymically from the TIME/MOMENT meaning due to the correlation between the canonical time period and the time this period takes to unfold. This is an instance of the Event-For-Time metonymy (Lakoff & Johnson 1999: 154–155).

In parallel, *hṓra*, which can refer to specific MOMENTS (OF THE DAY) as early as in Homer, as discussed above, extends in Classical Greek to the meaning DAY (NOT NIGHT), as illustrated in (6). To contextualize this example, Demosthenes, in his judicial oration *Against Midias*, describes some of the tricks Midias used in a past legal action. One of his tricks was to appear in court only when it was very late ('late in the day' as the passage translates):

6.

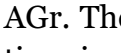
hōs	*oút'*	*egṑ*	*sunekhóroun*	*oúth'*	*hoûtos*
CONJ	NEG	1SG.NOM	refuse:1SG.IMPRF	NEG	DEM.NOM.SG.M

apénta,	***tês***	*d'*	***hṓras***
appear_to_defend:3SG.IMPRF	**ART.GEN.SG.F**	PTCL	**time(F):GEN.SG**

egígnet'	*opsé,*	*katediḗitēsen*
become:3SG.IMPRF.M/P	late	give_judgement_against:3SG.AOR

'as I continued to refuse and he (i.e., Midias) did not appear in court, and it was getting **late**, he gave his decision against him.' (Demosthenes, *Against Midias* 21.84; 4th c. BCE)

One can therefore posit a semantic extension from a non-specific meaning (appropriate) MOMENT IN TIME to more specific meanings, HOUR and DAY (NOT NIGHT) respectively. Note that the typological data support an extension from TIME, and not from SEASON, since the node SEASON is not directly connected to DAY (NOT NIGHT). However, we have at the same time to acknowledge a limitation of our methodology here, namely that the node TIME of the semantic map does not distinguish between the concrete meaning MOMENT IN TIME (when something happens), which is crucial in terms of diachronic evolution as we have just seen, and the more abstract meaning TIME, envisioned as the continuum of experience in which events pass from the future through the present to the past (see Table 3), which is not prevalent in the data. This results directly from the way the data were collected for CLICS[2] and consequently the semantic extension from MOMENT to TIME cannot be visualized on the map.

The AEg data confirm the list of semantic extensions described so far for AGr. The word  *nw* (*Wb*. 2, 219.1–15) refers to a (short) discrete interval of time in the earliest records but evolves towards the general expression of TIME from Late Egyptian onwards (and is especially frequent in phrases such as *m nw nb* 'at any time'). In (7), the TIME/MOMENT meaning is elaborated in terms of deictic motion, and it occurs in the collocation *jr nw* 'spend time (lit. make time)'[17] in (8):

7.

[17] Note that in similar contexts, the AGr lexeme *khrónos* can collocate with verbs that prototypically apply to resources (*tōi khrónōi dè kerdaneîs* 'you will gain time' (Euripides, *Orestes* 789)). In such examples—firstly attested in dramatic poetry—*khrónos* prompts for a reading in which an entity is inherently valuable (see Evans 2004: 178, Georgakopoulos & Piata 2012).

p; ***nw*** *jw*
ART.M.SG **time** come:RES
'The **time** has come' (P. Boulaq IV, 16,6; approx. 1200 BCE)

8.

jn *ntk* *p;* *nty* ***j-jr-f*** ***nw*** *jy-t* *n-j* *m_mnt*
INT 2SG.M ART.M.SG REL **FOC-do-3SG.M** **time** come-INF to-1SG daily
'Aren't you the one who **spends time** coming to me daily?' (P. Moscow 120, 1,x+8–9 [= *LES* 65,11–12]; approx. 950 BCE)

In Demotic (*EG* 210) and in Coptic (*CD* 234*b*–235*a*), this lexeme occurs in interrogative sentences for which the answers clearly show that the reference of *nw*/*nau* is contextually the precise moment in time, namely the HOUR, at which an event occured. An early example is (9), from a fragmentary Demotic story:

9.

nhs *PN* *šn-f* *r* ***p;*** ***nw*** *ntj* *ḫpr*
wake_up:PST PN ask:PST-3SG.M ALL **ART.M.SG** **time** REL become:RES
'PN woke up; He asked what **time** it was (lit. 'he asked about **the time** that had become'), (and he was told that it was the first hour of the night)' (P. Dem. Saqq. 2, col. x+1,20 [= Smith & Tait 1983: 111 & pl.]; approx. 300 BCE)

The meaning 'hour' of *nau* was however never fully semanticized in Coptic, since the lexeme *ounou* 'hour' (*CD* 484*b*–485*a*), which is attested in AEg since the earliest records as  *wnw.t* 'hour' (*Wb*. 1, 316.1-317.2), was still the most common lexification of hour during the latest stage of AEg.[18]

In addition to this incipient semantic extension, much like *hṓra* in AGr, *nau* developed new contexts of use in Coptic in which the lexeme refers to DAY (NOT NIGHT) or DAYTIME. Consider, for instance, example (10) from (Sahidic) Coptic.

10.

ntere *ou-noc* *de* ***n-nau*** *šôpe* *a-u-t^{i}peuouoei* *ero-f*
when.PST ART.INDEF-great PTCL **of-(day)time** happen:INF PST-3PL-come_up to-3SG.M
nci-nef-mat^{h}êtês *e-u-čô* *mmo-s* *na-f* *če* (…)
NOM-POSS.PL:3SG.M-disciple SBRD-3PL-say ACC-3SG.F to-3SG.M QUOT (…)
auô *a-p-nau-hôn* *e-oueine*
and PST-ART:M.SG-(day)time-approach to-pass_by

[18] Note that another lexeme, *čp* 'hour' (*CD* 777*b*–778a), whose etymology is not ascertained (*CED* 317), was almost exclusively used with a following numeral.

"But when a great deal of **daytime** had happened, his disciples came up to him, saying to him: '(the place is a desert) the **daytime** is near to pass away' " (New Testament, Mark 6:35; 3rd c. CE)[19]

In this passage where Jesus is about to feed the 5,000, the disciples are concerned about the fact that the end of the day is coming and that no food is available. Hence the interpretation of *nau* as referring specifically to DAYTIME and not simply to TIME seems highly plausible. Such examples are not rare, but it is admittedly difficult to find contexts in which the more general meaning TIME can be ruled out.

As such, both AEg and AGr support two semantic extensions from the general meaning TIME/MOMENT to specific time intervals, namely HOUR and DAYTIME.[20] The data discussed so far might seem to indicate that there is a unidirectional pathway going from TIME/MOMENT to HOUR. However, the AEg lexeme *wnw.t* 'hour' introduced above – which seems to have referred originally to the hours of the night, if one is to trust the classifier[21] ⋆ [STAR] in its ancient spellings:  – points to a bi-directionality. In specific constructions, this word indeed ended up expressing generic time-related meanings such as 'instant, moment', as shown by (11).

11.

jw-f	*ḥ3y-t*	*mwt*	*m*	***t3***	***wnw-t***	*šr(j)-t*
SEQ.PST-3SG.M	fall-INF	die:RES	in	**ART.F.SG**	**hour-F**	small-F

'and he fell dead at that very **instant**' (*Tale of the Two Brothers*, 12,7 [= *LES* 22,7]; approx. 1 200 BCE)

Two additional AEg lexemes undergo semantic developments that enable us to dynamicize other edges around the node TIME of the semantic map in Fig 8. The first one is  *tr* 'time, moment, season' (*Wb*. 5, 313,12–316,11), attested from Middle Egyptian onwards. *tr* refers to a given period of time, often with a

[19] For references to the Bible in Coptic, see Loprieno, Müller & Uljas (2017: 762–763).

[20] In this respect, note the similar semantic specification of another AEg lexeme,  *ꜣ.t* 'instant, moment' (*Wb*. 1, 1.12–2.2), which originally refers to the (instant of) attack of a leopard (Gardiner 1948: 13–15; Ogdon 1998) and probably took the meaning MINUTE (or the like) during the Ramesside period (c. 1 300–1000 BCE; see O. DeM 1080, r° 1–2 [= Posener 1938: pl. 45]; c. 1 150 BCE, with Fischer-Elfert 1997: 108–113), and certainly in texts from the Greco-Roman period (see, e.g., *Urk*. VIII, 23, 13–15).

[21] In the hieroglyphic script, classifiers (a.k.a. determinatives) are unpronounced graphemes that classify the unit they follow as belonging to a given semantic category (Goldwasser & Grinevald 2012, Lincke & Kammerzell 2012).

genitive expression pointing to periods of the year (12) or divisions of the day (Spalinger 1992: 151), as illustrated by (13).[22]

12.

pr_ḫrw	*n-sn*	***m***	***tr***	*nb*	*n*	*rnp-t*
offering	for-3PL	**in**	**time**	QUANT	n	year-F

'an offering for them at any **time** of the year' (Wooden door Cairo JE 47749 [= McFarlane 2003: pl. 15 & 50], approx. 2 400 BCE)

13.

 PN

jnyt	***m***	***tr***	***n***	***dwꜣw***	*m-ḏr-t*	PN
bring:PTCP.PASS	**in**	**time**	**of**	**morning**	by-hand-F	PN

'what has been brought **in the morning** by PN: (QUANTITY OF GOODS)' (P. Turin Cat. 2094, r° 8 [= K*RI* VI, 866,9]; approx. 1150 BCE)

This lexeme is not uncommonly used, as early as in Earlier Egyptian, for referring to the notion SEASON. It is then usually in the plural (14) or appears with a genitive expression specifying the period of the year (15).

14.

jr-k	***tr-w***	*r*	*s-ḫpr*	*jry-k*	*nb*
make:PST-2SG.M	**season-PL**	ALL	CAUS-happen:INF	make:REL.PST-2SG.M	QUANT

'You made the **seasons** in order to make everything you created grow (the winter to cool them and the heat that they taste you)' (*Great hymn to the sun*, l. 10–11 [Tomb of Eje = Sandman 1938: 95]; approx. 1 350 BCE)

15.

p.t	*ḥw=s*	*ḥr*	*ḥr-i*	***m***	***tr***	***n***	***šmw***
sky-F	rain:IPFV-3SG.F	on	face-1SG	**in**	**season**	**of**	**summer**

'(like) the sky raining on my face **during summertime**' (P. Turin 1993, l. 5 [= Pleyte & Rossi 1869: pl. 133]; approx. 1200 BCE)

Later on, *tr* extends towards the meaning AGE in some constructions (*CD* 319*b*) like *ei e-p-te* (come ALL-ART.M.SG-time) 'to reach time, age' or *r te* (make time) 'to be of age' (16), which points to a TIME → AGE extension.[23]

---

[22] The dual form *tr-wj* time-DU 'the two times' can be used with the meaning 'day and night' (cf. *Wb*. 5, 316,3–4).

[23] Note that the (period of) time denoted by *tr* could already extend to LIFETIME in Middle Egyptian (e.g. *Ptahhotep*, 7,9 [= Žába 1956: 30]; c. 1950 BCE) and that the phrase *m tr-k* (in time-2SG.M) means 'during your lifetime' in texts from the (late) Pharaonic period (*Wb*. 5,

16.

ntof	*hôô-f*	*a-f-**r-te***	*e-tre-f-šače*	*haro-f*
3SG.M	for_part-3SG.M	PST-3SG.M-**make-time**	ALL-CAUS-3SG.M-speak	about-3SG.M

‘(*we* do not know;) but he, for his part, **is old** enough (lit. has **done age**) to speak about himself’ (New Testament, John 9:21; approx. 3rd c. CE)

Finally, the word  *sw* (*Wb*. 4, 57,8–58,1) was used from the Middle Kingdom for referring to the ‘date’ or the ‘(calendric) day’ (as opposed to  *hrw* ‘day, daylight’, *Wb*. 2, 498,16–500,12). Progressively, it evolved towards the general meaning TIME. This change probably started as early as in Late Egyptian. The first occurrences of the etymologically redundant collocation *pꜣ sw hrw* ‘(lit.) the date-day’ (see *EG* 461–462) can be found during this period in contexts where the meaning DAY/DATE is required (17). In Demotic, there are many examples, such as (18), in which the meaning DAY/DATE is ruled out in favor of TIME (*EG* 461–462).

17.

mj	*sḏd-j*	*n-k*	*pꜣ*	*sḫr*	*n*	*wʿw*	(...)
come:IMP	tell:SBJV-1SG	to-2SG.M	ART.M.SG	condition	of	soldier	(...)

pꜣ	***sw***	***hrw***	*n*	*wḏ*	*n*	*wꜣs.t*	*r*	*jr-t*	*tꜣ*	*ʿb-t*
ART.M.SG	**date**	**day**	of	command:INF	to	Thebes	ALL	do-INF	ART.F.SG	festival-F

“Come that I tell you the condition of the soldier **on the day** when Thebes is due to make festival (in the cool winds of the second month of the winter)” (P. Chester Beatty 5, r° 6, 13–14 [= Gardiner 1935: pl. 25], approx. 1200 BCE)

18.

ṯꜣj	*pr-ʿꜣ*	*tꜣ*	*rsꜣ-t*	*n-rn-s*	*(n)*	*ḏrꜣ_ḏrt*	***n***	***ssw***	***sbḳ***
take:PST	Pharaoh	ART.F.SG	fortress-F	of-name-3SG.F	with	force	**in**	**time**	**small**

“Pharaoh took the said fortress by force **in a short time**’ (*Memphis Decree* [Rosetta Stone], l. 15 [= Simpson 1996: 262–263]; approx. 175 BCE)

By the time of Coptic, *sêu* (*CD* 367*b*–368*a*) was not only expressing the meaning TIME, but also SEASON in various contexts. This semantic extension appears to be more common in the Bohairic dialect (19), but is also present in Sahidic Coptic, as illustrated by (20).

19.

315,5–8), but it is only in Coptic that this lexeme is properly able to express the notion of AGE (and only in specific environments).

a-k-ti-xlom *ečen* *pi-kuklos* *nte* *ti-rompi* *xen* *pi-ftôou* *n-**cêou***
PST-2SG.M-give:INF-crown upon ART.M.SG-cycle of ART.M.SG-year at ART.M.SG-four of-**season**
'(and) you crowned (lit. 'put a crown upon') the cycle of the year in the four **seasons**' (Euchologium 2,270 [= Tuki 1771: co]; 2nd millenium CE)

20.
ne ***p-sêu*** *gar* *an* *pe* *n-knte*
NEG1 **ART.M.SG-season** indeed NEG2 COP of-fig
'It is indeed not the **season** of figs' (New Testament, Mark 11:12; 3rd c. CE)

The lexeme *sw/sêu* therefore undergoes a long-term evolution following the path DAY/DATE → TIME → SEASON. As observed above with other lexemes, it appears that the underspecified meaning TIME is again a bridge between semantically more specified senses such as AGE, DAY (NOT NIGHT), DAY (24 HOURS), HOUR, AND SEASON.

Fig. 9 summarizes the results of this section, with delta-shaped arrows between the meanings representing the diachronic connections identified in the corpus and diamond-shaped arrows visualizing reconstructed connections.

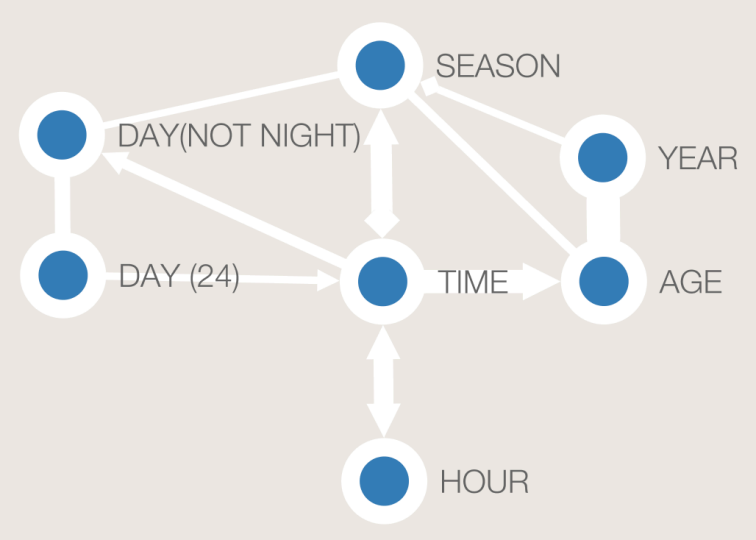


Figure 9. Dynamicized semantic map of TIME and its neighboring nodes

4.3.2. Semantic extensions of celestial objects

The <SUN, DAY (24 HOURS)> colexification is relatively frequent across languages. In CLICS², it is documented for 18 language varieties. AGr allows dynamicizing this link, since the word for SUN comes to mean DAY (24 HOURS). In Homeric

Greek, *ēélios* denotes only the celestial object, as illustrated by (21), and later on, in Classical Greek, it begins to designate the period between two sunrises, namely a DAY (24 HOURS). This extension is a novel metonymy occurring in poetic texts of the period (and this meaning is found in both the singular and the plural), as in (22).

21.

pân	*d'*	*êmar*	*pherómēn,*	*háma*	*d'*
whole:ACC.SG.N	PTCL	day(N):ACC.SG	carry:IMPF.1PL.M/P	ADV	PTCL

ēelíōi	***katadúnti***	*káppeson*	*en*	*Lémnōi*
sun(M):DAT.SG	**set:PTCP.AOR.DAT.SG.M**	fall:AOR.1PL	in	Lemnos:DAT.SG

'the whole day long I was carried headlong, and **at sunset** I fell in Lemnos' (Homer, *Iliad* 1.592-593; 8th c. BCE)

22.

ékheis,	*egő*	*te*	*sé:*	***hēlíous***	*dè*
have:PRS.2SG	1SG.NOM	PTCL	2SG.ACC	**sun(M):ACC.PL**	PTCL

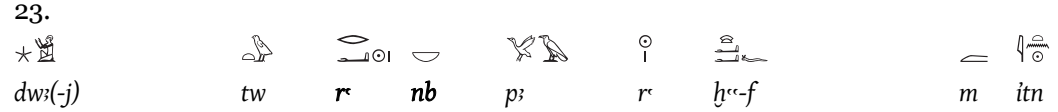
muríous	*mólis*	*dielthồn*	*ēisthomēn*
infinite:ACC.PL.M	ADV	pass:PTCP.AOR.NOM.SG.M	perceive:AOR.1SG.MID

tà	*tês*	*theoû*
ART.ACC.PL.N	ART.GEN.SG.F	god:GEN.SG

'You have (me), and I have you; although it was hard to live through **so many days**, I now understand the actions of the goddess.' (Euripides, *Helen* 652-653; 5th c. BCE)

AEg provides indirect evidence for the same extension. The lexeme  *rˁ* 'sun' (*Wb*. 2, 401,5–10) refers to the celestial body (and to the sun god Ra). The meaning of this word is very stable over time. As a matter of fact, in Coptic *rê* still means 'sun' and did not develop additional senses (*CD* 287*b*). However, it is also used (from the Old Kingdom onwards) with the quantifier *nb* in the temporal expression *rˁ nb* '(lit.) every sun' → 'every day', 'daily.' In (23), both meanings occur in the same sentence. Despite the fact that these are both already attested in the most ancient records, it is safe to posit an extension SUN → DAY (24 HOURS) given the collocational restrictions for the meaning DAY (24 HOURS) and the more abstract nature of this meaning.

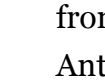
23.



dwȝ(-j)	*tw*	***rˁ***	***nb***	*pȝ*	*rˁ*	*ḫˁ-f*	*m*	*itn*

praise:SBJV(-1SG) 2SG.M **sun** **every** ART:M.SG sun appear:IPFV-3SG.M as solar_disk
'May I adore you **every day**, sun appearing as solar disc' (Tomb of Huya [= Sandman 1938: 38,8]; approx. 1350 BCE)

Note that AGr and AEg do not instantiate the cross-linguistically more robust pattern SUN-DAY (NOT NIGHT), which occurs 111 times in CLICS² (see also Youn et al. 2016), but the extension from the meaning SUN to a specific temporal interval linked to the Sun's behavior, i.e., to DAY (24 HOURS), which is metonymic as well.

A metonymic extension, but this time towards the meaning SUN and not from it, is observed in AEg. The word  *šw* '(sun)light' (*Wb*. 4, 430,6–431,12; Anthes 1963: 4–5) is attested since the beginning of the Middle Kingdom (c. 2 000 BCE), as illustrated by (24). By the beginning of the New Kingdom, this word extends to SUN, especially when preceded by the definite article, but not exclusively (25), and is still attested with this meaning in Demotic (*EG* 494).

24.

šmw	*bw_nb*	***m***	***šw-f***
go:REL.IPFV	everyone	**in**	**light-3SG.M**

'(Mentuhotep, leader of the black lands and of the red lands, …) **into whose light** everyone walks' (Stela of Mentuhotep, l. 11–12 [= Lange & Schäfer 1908,II: 153]; approx. 1950 BCE)

25.

n_ḏr	*jry-k*	*tw*	*m*	***šw***	*n*	*hrw*	*m*	*j·ḥ*	*n*	*grḥ*
since	make:SBJV-2SG.M	2SG.M	in	**sun**	of	day	in	moon	of	night

'(…) since you made yourself **sun** of the day and moon of the night' (Hymn to the night sun, r° 4–5 [= K*RI* VII, 379,8–9]; approx. 1100 BCE)

Further interesting metonymical associations can be observed in the domain of celestial phenomena: AGr co-expresses the meaning MOON and MONTH, a very prominent colexification pattern across languages (it appears in 294 language varieties in CLICS²; see also Youn et al. 2016).[24] In Greek, the lexeme *selḗnē* originally referred to MOON (26), and in Classical Greek it extended to MONTH. In (27), Admetus commands all citizens in his realm to join him in mourning for his wife, Alcestis, for one whole year, namely 12 months.

[24] Note that, despite the occurrence of the sign of the crescent moon in the hieroglyphic spelling of  *ꜣbd* 'month' (*Wb*. 1, 65,5–9) in AEg, this word is unrelated to  *j·ḥ* 'moon' (*Wb*. 1, 42,7–9) that keeps this sole meaning down to Coptic *ooh* 'moon' (*CD* 257*b*–258*a*).

26.

oudè	***selḗnē***	*ouranóthen*	*proúphaine*
NEG	**moon(F):NOM.SG**	sky.ABL	show.up:IMPRF.3SG

kateíkheto	*dè*	*nephéessin*
cover:IMPRF.3SG.M/P	PTCL	cloud(N):DAT.PL

'**the moon** showed no light from heaven, but was shut in by clouds.'
(Homer, *Odyssey* 9.144-145; 8th c. BCE)

27.

aulôn	*dè*	*mḕ*	*kat'*	*ástu,*	*mḕ*	*lúras*
flute(M):GEN.PL	PTCL	NEG	down	city(N):ACC.SG	NEG	lyre(F):GEN.SG

ktúpos	*éstō*	***selénas***	***dṓdek'***	*ekplērouménas*
sound(M):NOM.SG	be.3SG.PRS.IMPER	**moon(F):ACC.PL**	**twelve**	fill.up:PTCP.PRS.M/P.ACC.PL.F

'And let there be no sound of flute or lyre in the city for **twelve** full **months**.'
(Euripides, *Alcestis* 430-431; 5th c. BCE)

In the same period, *selḗnē* also expresses DAY (24 HOURS), a meaning that is related to MOON through metonymy (in the same way that DAY (24 HOURS) is associated with SUN). In (28), *selḗnē* cannot be interpreted as 'month' (as was interpreted in Liddell-Scott 1996; cf. Montanari 2015), because the passage refers to the period in which a woman was considered ritually unclean, that is ten days after the birth (see Roisman & Luschnig 2011: 178, 218). This meaning is found again in poetic texts (in fact only in Euripides).

28.

toútōn	*húper*	*moi*	*thûson*	–	*ou*	*gàr*	*oîda*
DEM.GEN.PL	over	1SG.DAT	sacrifice:2SG.IMP.AOR		NEG	PTCL	know:1SG.PRS

egṓ	—	***dekátēi***	***selḗnēi***	*paidòs*	*hōs*
1SG.NOM		**tenth:DAT**	**moon(F):DAT.SG**	child(M):GEN.SG	CONJ

nomízetai:
be.customary:3SG.PRS.M/P

'in thanks for this, please sacrifice—for I do not know how—on **the tenth day**, as is the custom for the child.' (Euripides, *Electra* 1125-1126; 5th c. BCE)

Since the <MOON, DAY (24 HOURS)> colexification is not attested in the CLICS² language sample, it is absent from the semantic map in Fig. 8. This (directed) edge is introduced in the dynamicized semantic map in Fig. 10 which summarizes the cases studied in this section.

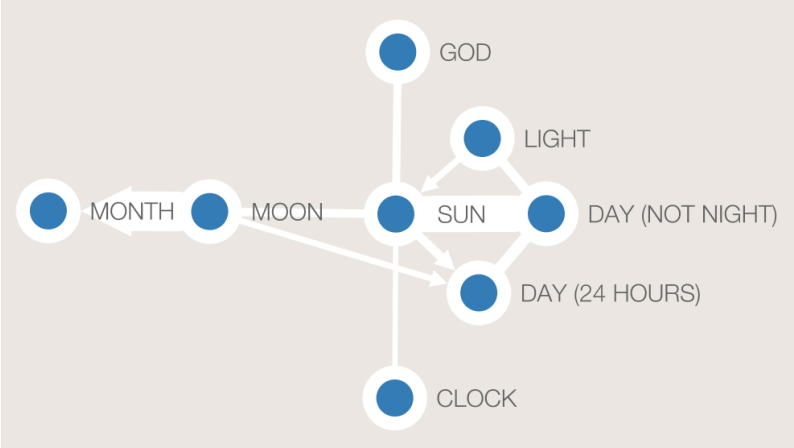


Figure 10. Dynamicized semantic map of MOON/SUN and their neighboring nodes

4.3.3. Diachronic extensions to new meanings

The last semantic extension discussed—namely from MOON to DAY (24 HOURS)—illustrates the fact that additional edges have to be introduced in the map as a result of the diachronic semasiological analysis. In Section 3, we defended the methodological decision to remove infrequent edges, arguing that it is crucial, given the diachronic nature of our research question, to investigate commonly associated meanings in the first instance. We also noted that, given the threshold we set, some interesting associations will go unnoticed. In the following section, we show how we compensate for this temporary loss of information. In particular, the diachronic investigation of the AEg and the AGr material reveals (a) colexifications that are already present in the CLICS² database but were removed based on the threshold that only accepts a given colexification if it occurs more than six times in the dataset, and (b) colexifications that are absent from the CLICS² database altogether, simply because the concepts were not among those elicitated in CLICS²'s source.

(a) *From SUMMER to HARVEST*

A colexification that is re-introduced following our semasiological analysis is the <SUMMER, HARVEST> colexification, which is attested in both AEg and AGr[25]. In both languages, it passes the criterion that acknowledges as diachronic colexification the association of a single lexeme with two related meanings across different stages. In AGr, during the first diachronic stage (in Homer and Hesiod), the lexeme *théros*[26] had a single meaning, which referred to the specific season

[25] This colexification is not atypical at least in Indo-European (see Gothic *asans* as well as the proto Indo-European root **-es/ -en*, **os-en-*; Buck 1949: 1014-1015, Pokorny 2007: 937).

[26] *Théros* is based upon a root meaning WARM: **gwher-mo-* (Beekes 2010: 541).

(29). It is only in Classical Greek that it extends its semantic load and means HARVEST as well (30).[27]

29.

autàr	*epèn*	*élthēisi*	***théros***
PTCL	when	come:AOR.SBJV.3SG	**summer(N):NOM.SG**

tethaluîá	*t'*	*opṓrē*
thrive:PTCP.PRF.NOM.SG.F	PTCL	autumn(F):NOM.SG

'But when **summer** comes and rich autumn' (Homer, *Odyssey* 11.192; 8th c. BCE)

30.

kâit'	*anèr*	*édoksen*	*eînai,*	*tallótrion*
ADV	man:NOM.SG.M	seem:AOR.3SG	be.INF	another:ACC.SG

amôn	***théros***
reap.corn:PTCP.PRS.NOM.SG.M	**summer(N):ACC.SG**

'he has only made himself a name by reaping another's **harvest**' (Aristophanes, *Knights* 392/ 5th c. BCE)

In AEg,  *šmw* 'summer' (*Wb*. 4, 480,5–14) refers to one of the three seasons (of four months) of the Ancient Egyptian calendar (31), which characterized by high temperatures (as opposed to *pr.t* 'winter (lit. germination)', which comes after *ꜣḫ.t* 'the flood'). This lexeme was certainly derived from the root *šm* 'to be hot'. It is attested already during the Old Kingdom and is still present in Coptic (*šôm*) with the same meaning (*CD* 564*b*).

31.

wn-ḫr	*p-t*	*m*	*ḥtpw*	***hrw-w***	***šmw***	*ḫpr*	*m*	*pr-t*
be-NEC	sky-F	in	peace	**day-PL**	**summer**	become:STAT	in	winter-F

'(then his father Seth heeded all that he had said), and consequently the sky was calm, **summer days** occurring in the winter season' (Firs Hittite Marriage [K*RI* II, 250,3–6]; approx. 1 250 BCE)

[27] Homeric Greek uses the lexeme *karpós* 'fruit, the produce of one's land' for HARVEST.

From the Middle Kingdom onwards *šmw* extends to the meaning ‘summer crops, harvest’ (*Wb.* 4, 481,1–10; Caminos 1954: 248 & 309; van den Boorn 1988: 244–245). The word is then normally written with the [GRAIN] classifier as (32).

32.

jḫ-dj-k	*ḥr-k*	*r*	*nwy-t*	***pꜣ***	***šmw***	*pr-ꜥꜣ ꜥ.w.s*
OPT-give-2SG.M	face-2SG.M	ALL	gather-INF	**ART.M.SG**	**harvest**	Pharaoh L.P.H.

‘May you see to gather **the harvest** (of) Pharaoh L.P.H. (which is under your responsibility)’ (P. Chester Beatty V, v^{o} 1,5–6 [= Gardiner 1935,II: pl. 26]; approx. 1200 BCE)

The AGr and AEg semantic extension from SUMMER to HARVEST fits the parameters of a metonymic association. In this case, the particular period, namely summer, is linked to a salient activity associated with the period, namely harvesting. SUMMER and HARVEST belong to the same domain/frame and within this domain, SUMMER is the vehicle that provides mental access to the HARVEST (see Kövecses & Radden 1998 for a definition of metonymy that builds on the notions of vehicle and target; cf. Croft 1993, Lakoff 1987). Note that the opposite metonymic evolution is attested in English, with ‘harvest’ used as a designation of the third season of the year before the introduction of the French loan word ‘autumn’ during the 14th century (Fischer 1994). There is evidence for the same change in Chinese for the word 秋 *qiū* (Yun 2015: 130–131), originally referring to ‘grain ripened,’ but extending to meanings such as ‘harvest season’, ‘autumn’, ‘period of time’, and ‘year’ in Mandarin Chinese.

In AEg, the evolution is interestingly not limited to a SUMMER → HARVEST diachronic colexification: (32) is a bridging context that illustrates how the extension from HARVEST to (HARVEST) TAX was made possible. This meaning is well attested in Late Egyptian and Demotic (*EG* 507; cf. Vandorpe 2000) and, by the time of Coptic, *šôm* has the general meaning ‘tax, tribute’ (33) in addition to ‘summer’ (*CD* 564*b*).

33.

auô	*e-f-kôlue*	*e-t^{i}-**šôm***	*m-prro*
and	SBRD-3SG.M-forbid	ALL-give:INF-**tribute**	to-king

‘(we found this man misleading our nation) and forbidding to give **tribute** to the king (and saying that he himself is Christ a king)’ (New Testament, Luke 23:2; approx. 3rd c. CE)

(b) *From SPRINGTIME to YOUTH*

It is not uncommon for a human lifetime to be described in terms of a temporal interval. The conceptualization of human life in such terms is ubiquitous in Greek mythology and this has been pointed out in several cognitive linguistic studies. Kövecses (2010: 11), for instance, mentions the riddle posed by the Sphinx to Oedipus, which Oedipus had to solve in order to continue on his way. The Sphinx asks him: What walks on four feet in the morning, two in the afternoon and on three at dusk?[28] Oedipus succeeds in deciphering the riddle by resorting to the metaphorical structure of its building blocks. He answers that it is the human being that goes on all fours in the morning (i.e., in infancy), on two in the afternoon (i.e., in maturity) and on three at dusk (i.e., in old age). Oedipus understands that the parts of the day, i.e., the source domain, are mapped onto the periods of a human being's life, i.e., the target domain (for the metaphor A LIFETIME IS A DAY, see also Lakoff & Turner 1989: 11-12).

Against this backdrop, it is unsurprising that we find reflections of these conceptualizations in our corpus, where a human lifetime is described as a natural cycle of the year. Take for example (34):

34.

eph'	*hoîs*	*prosékei*	*semnúsesthai*	*tèn*	*pólin,*
SUPR	REL.DAT.PL.M	belong:PRS.3SG	exalt:INF.M/P	ART.ACC.SG.F	city(F):ACC.SG

eàn	*kállei*	*kaì*	***hṓrai***	*dienegkóntes*
CONJ	beauty:DAT.SG.N	CONJ	**youth(F):DAT.SG**	differ:AOR.PTCP.NOM.PL.M

ekpléksōsí	*tinas*	*kaì*	*perimákhētoi*	*eks*
amaze:3AOR.SBJV	INDEF.ACC.PL.F	CONJ	fought_for:NOM.PL.M	ELAT

erōtos	*génōntai*
love(M):GEN.SG	be.AOR.SBJV.3PL.MID

'of whom the city may well be proud, if by their surpassing beauty and **youthful charm** they infatuate one person or another and become the subject of strife because of the passion they inspire' (Aeschines, *Against Timarchus* 1.134 / 5th c. BCE)

In this example, *hṓra* refers neither to a season nor to a moment in time (cf. §4.3.1), but to a particular time in someone's life, namely youth (cf. the adjective *hōraîos* 'in the prime of life, youthful'–when referring to age). In this respect, it in interesting that in Pindar, *Hṓra* is the personified beauty of youth (see Pindar, *Nemean* 8.1). The early stage in the life cycle is conceptualized as a

[28] Sophocles at no point in the work mentions the riddle explicitly. For some indirect references to the riddle, see *Oedipus Tyrannus* 130, 391-398, 1198-1200.

season along the lines of the LIFE IS A YEAR metaphor.[29] The question then arises as to which season is connected to youth. The various lexicographical resources link *hṓra* either indirectly (e.g., Beekes 2010: 1681 gives the meaning FLORESCENCE) or directly (e.g., Liddell & Scott 1996: PRIME OF THE YEAR, SPRINGTIME) to the SPRINGTIME concept. In Homer, *hṓra* prompts a SPRINGTIME reading in conjunction with an expression referring to this season. In the few examples in which *hṓra* does not collocate with such an expression, the lexeme does not have a conventional reading SPRING, which only emerges in its interaction with lexical elements that are associated with the concept of SPRING, e.g. blossoming flowers (35):

35.

Éstan	*d'*	*en*	*leimôni*	*Skamandríōi*	*anthemóenti*
stand:AOR.3PL	PTC	INESS	mead(M):DAT.SG	Scamander:DAT	flowery:DAT

muríoi,	*hóssá*	*te*	*phúlla*	*kaì*	*ánthea*
infinite:NOM.PL.M	REL.ACC.PL.N	PTC	leaf(N):NOM.PL	CONJ	flower(N):NOM.PL

gígnetai	***hṓrēi***
be.3SG.MID	**season(F):DAT.SG**

'So they took their stand in the flowery mead of Scamander, numberless, as are the leaves and the flowers in their **season**' (Homer, *Iliad* 2.467-468/ 8th c. BCE)

The same holds true for Classical Greek. In (36) taken from Aristophanes, it is the presence of *khelidṓn* ('swallow') that establishes the association of *hṓra* with spring.

36.

sképsasthe	*paîdes:*	*oukh'*	*horâth';*	***hṓra***
look:AOR.IMP.2PL.M/P	child(M):VOC.PL	NEG	see:PRS.IMP.2PL	**season(F):NOM.SG**

néa,	*khelidṓn.*
new:NOM.SG.F	swallow(F):NOM.SG

"Look, friends don't you see a swallow? It's the herald of **springtime**." (Aristophanes, *Knights* 419/ 5th c. BCE)

The frequent association between *hṓra* and the contextual meaning SPRINGTIME may have favored the conventionalization of this specific meaning. Thus, we speculate that the concrete mapping should be from SPRINGTIME to YOUTH, a

[29] For this metaphor, see among others Lakoff & Turner (1989: 18), Sullivan (2017: 387).

mapping based on an analogy between the two periods. This explanation is supported by the fact that the mapping of the year onto the human life cycle constitutes a structuring metaphor of Greek mythology. In Greek mythology, one can find an association of youth with springtime, of adulthood with summer and of old age with winter (see Sweetser 1995: 587).

AEg does not provide direct evidence for the same diachronic colexification, but it supports an indirect connection between TIME/SEASON and YOUTH. Indeed, several time-related lexemes mentioned in Section 4.3.1 (such as *ꜣ.t* 'moment,' *wnw.t* 'hour,' *nw* 'moment, time,' *tr* 'time, season') can occur in a construction [IN/AT TIME_LEXEME POSSESSOR] with the meaning 'in/at its (her/his) best (appropriate/fitting) time', which is semantically close to YOUTH. The lexeme *tr* 'time, season' in (37) illustrates this meaning which Chantrain (Fthc.) labeled 'moment of climax'.

37.

rnpj	*sw*	*r*	***tr-f***
rejuvenate:PTCP.IPFV	3SG.M	at	**season-3SG.M**

'(a god who hides his images in his sky,) who rejuvenates himself at **his (best) season**' (P. Leiden I 344, v^{o} 8,7–8 [= Zandee 1992]; approx. 1250 BCE)

The SPRINGTIME-YOUTH colexification is not included in CLICS^{2}. Thus, an additional (directed) edge has to be added in order to connect the two concepts and visualize the diachronic colexification.

(c) *From TIME to SPACE*

In addition to diachronic colexifications that are shared across different languages, our dataset reveals an unexpected pathway of change, which is likely to be language-specific: the extension from time to space for the AEg lexeme *rk* 'period, time' (*Wb.* 2, 457,4–458,3). This word has been attested since the Old Kingdom, and refers to the 'time' or 'period of somebody or something,' always with a genitive construction as illustrated by (38):

38.

nn	*wn*	*jr*	*mj_ḳd-s*	*ḏr*	***rk***	***nṯr***
NEG	EXIST	do:PTCP.PASS	similar-3SG.F	since	**time**	**god**

'(I made for you a venerable balance of electrum,) the equivalent of which has not been made since **the time of god**' (P. Harris I, 26,11 [Erichsen 1933: 31,1–2]; approx. 1150 BCE)

As is apparent from (38), the time reference of *rk* is the period during which an individual (or thing) used to live (or exist), and this period is conceived as a kind of container surrounding him. During the New Kingdom, this lexeme develops new contexts of use, especially in the high registers of royal inscriptions and funerary texts, where it has the spatial meaning 'in the surroundings of, around.' This spatial meaning is the only possible reading in examples like (39):

39.

sbty	*n*	*ds*	***m***	***rk***	***tꜣ-mrj***
wall	of	flint	**in**	**time**	**country-beloved**

'(Ramesses 2, lord of the two lands as Atum,) wall of flint **around Egypt** (protecting his army)' (First Hittite Marriage [K*RI* II, 235,7–8]; c. 1200 BCE)

This extension from time to space is cross-linguistically extremely rare (Haspelmath 1997). However, what seems unsystematic from a cross-linguistic point of view turns out to be motivated intra-linguistically. As a matter of fact, it has long been noted (*Wb*. 2,458,2) that another AEg lexeme has the same kind of polysemy pattern:  *ḥꜣw* (*Wb*. 2, 477,1–478,10) has denoted both temporal (40) and spatial (41) proximity since the Old Kingdom (Feder 2003):

40.

m	*ḥꜣw*	*nb-tꜣ-wy*	*nb_pḥty-rꜥ*
in	**proximity**	lord-land-DU	Nepehtire

'(And then I became a soldier (…),) **during the time** of the lord of the Two Lands, Nebpehtire (justified, when I was a young man, not having a wife yet)' (Biography of Ahmose [= *Urk*. IV, 2,12–15]; approx. 1500 BCE)

41.

m	*ḥꜣw*	*nh-t*
in	**proximity**	Sycamore-F

'(I crossed the place called The Two Truths,) **in the vicinity** of The Sycamore" (and I landed at The Island of Snefru)' (Sinuhe, B8 [= Koch 1990: 14]; approx. 1850 BCE)

We argue here that the pre-existing polysemy pattern of *ḥꜣw*, which refers to both spatial and temporal proximity, served as a language-internal template for the extension of the meaning of the temporal lexeme *rk* to space. This analogical

process is facilitated by the fact that *rk* and *hꜣw* occur in the same construction [IN LEXEME POSSESSOR]. To formulate it in general terms: a lexeme L_1 and a lexeme L_2 in the same language and at the same diachronic stage share the same function M_1. L_1 also has the function M_2. In the course of language evolution, L_2 extends its range of meaning by analogy with L_1, given the shared constructional environment, and come to mean M_2 as well. As a result, the functions of the two markers are aligned.

This account is actually the language-internal version of the process known as polysemy copying in language contact studies: "at a first stage, a marker of one language and a marker of some contact language have overlapping functions, or one of the markers is more specific than the other. (…) Accordingly, the functions of the two markers may by 'aligned', i.e. their range of meaning may become more or less identical" (Gast & van der Auwera 2012, Heine & Kuteva 2003, 2005).

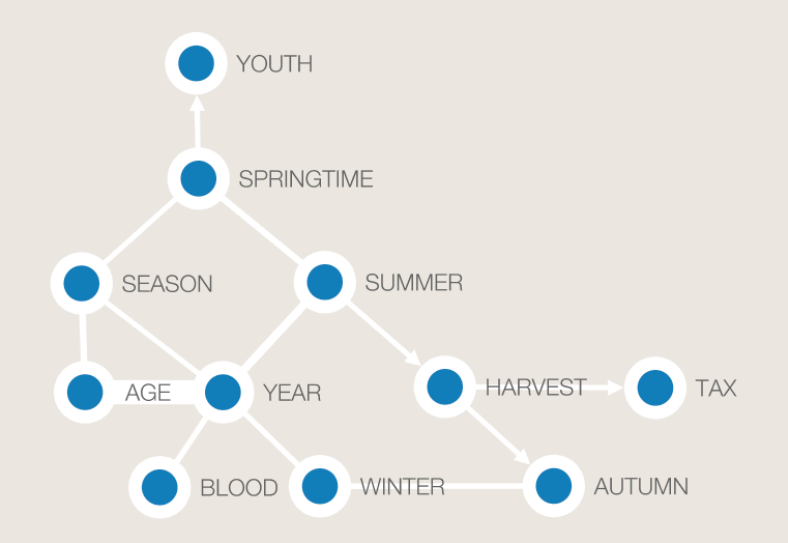


Figure 11. New semantic extensions added to the map

5. Conclusions

Bringing together research on semantic maps and meaning change, the present paper contributes to the field of diachronic lexical semantics in several ways. Extending previous research on semantic maps, the study–with its focus on the lexicon and diachrony–demonstrates that the semantic map model is a representational model that can be used efficiently for any type of meaning and for any dimension (synchronic or diachronic). Specifically, the study provides a protocol for plotting diachronic semantic maps of any lexical semantic field. From a methodological perspective, this protocol is important because the output of diachronic investigations can be assessed against the background of big typological data about synchronic meaning associations. Indeed, despite its

diachronic orientation, the protocol does not ignore synchrony. Quite the opposite: the construction of a synchronic map as a first step is crucial. It is inferred from recurrent colexification patterns and contains information about frequency of these patterns. Importantly, by relying on typological evidence, the resulting graphs are not language-specific polysemy networks, but cross-linguistically relevant semantic maps. On the contrary, the integration of the diachronic dimension results from language-specific qualitative research, and is informed by the colexification patterns attested in the languages of the world. The present study also shows how statistical analyses of graphs can reveal details otherwise 'hidden' in the network, such as meaning communities that are difficult to objectivize based on deductive semantic analysis (cf. Fig. 5–7). Finally, it demonstrates that network visualizations are not just a convenient way of displaying the results, but support the in-depth diachronic semantic analysis in an instrumental and meaningful way.

This study also highlights challenges for future studies in the field. First, the investigation of meaning extensions in the AEg and AGr lexicon has demonstrated that the general concepts used for collecting typological data are usually not precise enough if one aims to account for the micro-steps of meaning change that are actually attested in historical corpora. A case in point is the concept TIME, defined as 'a continuum of experience': this concept not only covers the general meaning TIME, but it also encapsulates hyponyms, such as the time intervals usually referred to as 'duration', 'moment' or 'period' in English (cf. §4.3.1). A recurring pattern in the diachronic material is the extension from these concrete time intervals to the more abstract meaning TIME. The visual representation of such an extension poses a challenge, since there is no principled way to connect these meanings with the other concepts on the map.

Second, the conditions under which a directed edge can be added are not unproblematic. To start with, historical priority of one meaning over another is a necessary but not sufficient condition for a directionality to be established. Factors other than the temporal ordering of meanings should be taken into account as well. Specifically, one should be able to show (a) that the meaning extension occurs in more than one language, which decreases the chance of its being idiosyncratic (our case study with two languages that give access to diachronic material can be seen as a step in this direction), and (b) that the extension has a clear semantic motivation. A relationship of Meaning A and Meaning B is considered *motivated* "just in case there is an independently existing link, L, such that A-L-B "fit together." L makes *sense of* the relationship between A and B." (Lakoff 1987: 448). The paper identifies such cognitive motivations behind the changes in meaning. In particular, it considers changes resulting from either similarity of meaning (metaphor) or contiguity of meaning

(metonymy). Table 5 presents the full list of semantic extensions discussed in the paper.

Table 5. List of semantic extensions in the temporal domain discussed in the paper

Extension	Mechanism	Language
TIME→AGE	metonymy	AEg
DAY(24)→TIME	metonymy	AEg
TIME→HOUR	metonymy	AGr
HOUR→ TIME	metonymy	(AEg)
TIME→SEASON	metonymy	AEg
SEASON→TIME	metonymy	AGr
TIME→DAY(NOT NIGHT)	metonymy	AEg; AGr
YEAR→SEASON	metonymy	AGr
DAY(24)→HOUR	metonymy	AGr
MOON→MONTH	metonymy	(AGr)
MOON→DAY(24)	metonymy	(AGr)
SUN→DAY(24)	metonymy	(AEg)
LIGHT→SUN	metonymy	AEg
SPRINGTIME→YOUTH	metaphor	AGr
SUMMER→HARVEST	metonymy	AEg; AGr
HARVEST→TAX	metonymy	AEg
HARVEST→AUTUMN	metonymy	Old English; Chinese
SPRINGTIME→SUMMER	metonymy	Romanian

However, it is not always straightforward to decide in a principled way on what counts as meaning extension. Our analysis revealed at least three problematic cases (the parenthesis in the column 'language' of Table 5 points to these cases):

(a) cases in which the extension is limited to a specific constructional environment (e.g., SUN→DAY(24) in AEg, cf. 4.3.2);
(b) cases in which the extension is restricted to specific registers (e.g., MOON→DAY(24) in AGr poetry, cf. 4.3.2); and
(c) cases in which the reference of a lexeme corresponds contextually to a given concept, but this meaning is not properly conventionalized (e.g., the meaning HOUR for *nau* 'time' in Coptic, cf. 4.3.1).

The distinction between low and high transparency for the edges in the map in Fig. 12 reflects this opposition between what we term strict diachronic colexification (which refers to meaning extensions that are conventionalized) and loose diachronic colexification (which refers to extensions that are limited to some — constructional, diaphasic, etc. — contexts).

Another question that arises concerns the inclusion of metonymical extensions–which characterize the vast majority of the observed extensions–in

the map given the potential bi-directional nature of this type of change (e.g., TIME↔HOUR, TIME↔SEASON): metonymy is characterized by the schematic formula "B for A", but in a given pair of meanings, each meaning can occupy either slot. This definitional feature of metonymies sets at risk the very interest of diachronic maps: if both directionalities are possible, the resulting map ends up being diachronically vacuous (Haspelmath 2003: 218, Narrog 2010: 233–234, van der Auwera 2013: 166). However, there are two important reasons in favor of such inclusion. First, assigning different flags to the edges of a semantic map referring to semantic relations gives a more thorough picture of the semantic domain(s) in question. Second, although both directionalities are possible, it is an empirical question whether they are equally attested in the languages of the world. Again, our small diachronic sample started providing answers in this direction, with some directionalities better established than others.

Finally, in representational terms, the diachronic micro-maps presented so far (Fig. 9–11) are actually problematic in that they dynamicize directly weighted edges: this implies that all languages of the dataset support the said pathway of change from one meaning to another, which is quite obviously not the case.

The final map in Fig. 12 is an effort to address the issues discussed above. We suggest that an efficient solution to circumvent them is to resort to mixed multigraphs, i.e., graphs with multiple edges between nodes that can be either directed or undirected. This allows us to differentiate between edges that are inferred from synchronic co-expression patterns, on the one hand, and edges resulting from diachronic analysis, on the other hand, to distinguish between different kinds of relationships between meanings (metonymy vs. metaphor) and different degrees of conventionalization for meaning extensions. In order to do so, we use different visual properties, such as the type of line, the type of arrows and the transparency of the links that are listed in Table 6.

Table 6. Different types of interaction between the nodes of the map

Type of interaction	**Edge property**
undefined	solid line
metonymy	dashed line
metaphor	vertical slash line
synchronic colexification	white
diachronic colexification	grey
Directionality	**Arrow property**
reconstructed connection	diamond shaped arrow
attested connection	delta shaped arrow
Type of extension	**Edge transparency**
loose diachronic colexification	low
strict diachronic colexification	high

To the best of our knowledge, the resulting map in Fig. 12 is the first lexical semantic map based on cross-linguistic material that integrates the diachronic dimension: it treats synchronic and diachronic colexification patterns in a unified fashion without merging different types of information. As such, it functions as a methodological bridge between language specific polysemy networks (For AGr, see Georgakopoulos & Piata 2012; for AEg, see Nyord 2012 and Winand 2015) and typological generalizations.

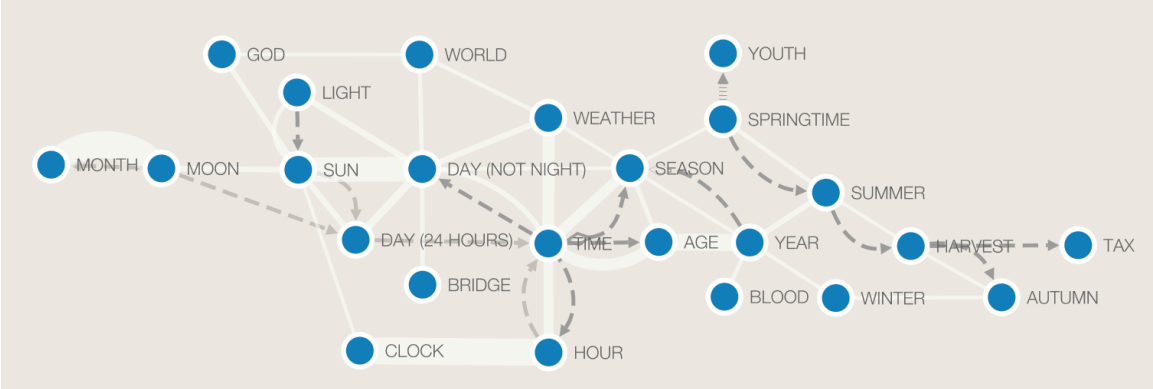


Figure 12. Mixed multigraph of the domain of time

In representational terms, the graph in Fig. 12 offers new perspectives for visualizing the relationships between meanings in diachrony. While the findings summarized in this mixed multigraph have to be tested empirically and might still be falsified by additional cross-linguistic and diachronic evidence, the proof-of-concept presented herein, which articulates synchronic typological generalization and language-specific diachronic information, is a methodological step forward in the study of the structure of the lexicon and its diachronic evolution.

Glossing abbreviations

1	1st person	DIR	directional	INT	interrogative
2	2nd person	ELAT	elative	IPFV	imperfective
3	3rd person	EXIST	existential	LAT	lateral
ACC	accusative	F	feminine	M	masculine
ADV	adverb	FOC	focalizer, focalizing form	M/P	medio-passive
ALL	allative	GEN	genitive	MID	middle
AOR	aorist	IMP	imperative	N	neutral
ART	article	IMPRF	imperfect	NEC	modal necessity
CAUS	causative	INDEF	indefinite	NEG	negation
CONJ	conjunction	INESS	inessive	NOM	nominative
COP	copula	INFR	inferior	OPT	optative
DAT	dative	INF	infinitive	PL	plural
DEM	demonstrative			POSS	possessive

PRF	perfect
PRS	present
PST	past
PTCL	particle
PTCP	participle
QUANT	quantifier
QUOT	quotative
REL	relative marker / relative form
RES	resultative
SBJV	subjunctive
SBRD	subordinating particle
SEQ	sequential
SG	singular
STAT	stative
SUPR	superior
VOC	vocative

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