Maria Koptjevskaja-Tamm*

Semantic maps and temperature: Capturing the lexicon-grammar interface across languages

Abstract: Traditionally, lexical typology has to a large extent been interested in *lexical categorization* of various cognitive domains (e. g., COLOUR, PERCEPTION, BODY), i. e., in how these are cut up by the most important words in a language, and in *lexical motivation*, or formal relatedness, i. e., in whether words for certain concepts are completely unrelated or related to others via polysemy or derivation (e. g., intransitive vs. transitive verbs, words for 'day' and 'sun', etc.). *Grammatical behavior* of words and *morphosyntactic patterns* as encoding meanings traditionally belong to grammatical typology. In this paper, I consider the domain of TEMPERATURE and show how the close interaction between lexicon and grammar in the encoding of the temperature domain across languages calls for an integrated lexico-grammatical approach to these phenomena. As a useful tool for such an enterprise I suggest an elaborated semantic map comprising three layers – the layer specifying the words with the information on their mutual formal relations (i. e., whether they are identical, completely unrelated or related via derivation or inflection), their morphosyntactic properties (e. g., their part-of-speech affiliation, inflectional potential, etc.), and the constructions they occur in.

Keywords: temperature terms, predicative constructions, lexical motivation, categorization, lexical typology, grammatical typology

1 The temperature domain and frames of temperature evaluation

TEMPERATURE is usually included among property concepts, e. g., as a subcategory of the class of PHYSICAL PROPERTIES in Dixon's (2004) influential list of concepts that are often lexicalized as adjectives. However, temperature concepts have a remarkable status among property concepts in applying to very different states of affairs. Now, dimension, evaluation or age can of course also pertain to wildly

*Corresponding author: Maria Koptjevskaja-Tamm, Department of Linguistics, Stockholm University, Stockholm, Sweden, e-mail: tamm@ling.su.se

different entities and situations. However, what probably singles out temperature concepts is the fact that they are regularly found in three (or even four) fundamentally different kinds of situations (ex. (1)), which will be called *frames, subdomains*, or *kinds of temperature evaluation* (Koptjevskaja-Tamm 2015). The notion of a frame, as used here, corresponds to the notion of semantic frames introduced by Fillmore (1977; 1985) and utilized in FrameNet (http://framenet.icsi.berkeley.edu/) as a description of a type of event, relation, or entity and the participants in it.[1]

(1)   Frames of temperature evaluation

      a.   TACTILE TEMPERATURE, or "TOUCH-TEMPERATURE": *The stones are hot*.
      b.   PERSONAL-FEELING TEMPERATURE: *I am hot*.
      c.   AMBIENT TEMPERATURE: *It is hot here*; *The summer was hot*.

First of all, there are uses like *The stones are hot/cold* or *hot/cold stones*, in which temperature concepts describe properties or states of particular concrete entities, *carriers of properties*, and align with property concepts in general ('dark', 'big', 'sharp', etc.). These uses belong to the TACTILE temperature frame.

    Then there are examples like *I am/feel hot/cold*, which describe a very subjective experience of PERSONAL-FEELING temperature. These are bodily sensations involving sentient, usually human *experiencers*, on a par with others, such as feeling hungry/thirsty, having pain etc. (Verhoeven 2007: 42–43). A person can feel hot or cold due to various reasons, which makes bodily sensations different from physical properties and states.

    Finally, we find temperature expressions in examples like *It is hot/cold here* or *a hot/cold day*, which describe temperatures related to certain circumstances – these are AMBIENT temperatures. In contrast to both TACTILE and PERSONAL-FEELING temperatures, predications about AMBIENT temperatures do not have to involve participants.

    However, AMBIENT temperatures may also be construed as properties of particular entities, both concrete and abstract – places (indoors, such as houses and saunas, or outdoors, such as countries), sources and conductors of heat (sun, fire, air, wind), weather and climate, and time periods (days, months, etc.). The contrast between the English sentences *It was cold in March/in the house* and

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1 The notion of frames is likewise central in the frame-based approach to lexical typology (Rakhilina and Reznikova 2016; Rakhilina et al. 2022), which, in contrast to FrameNet, takes the semantic properties of the arguments rather than their syntactic roles as the point of departure for defining frames. This difference seems to be irrelevant for the frames of temperature evaluation as elaborated here.

March/The house/The weather was cold shows this difference between what I call "NON-REFERENTIAL AMBIENT temperature", lacking reference to any participants in the corresponding situations, and "QUASI-REFERENTIAL AMBIENT temperature"[2] respectively.

The versatile uses of the temperature terms such as 'hot' or 'cold' along the distinction between TACTILE, PERSONAL-FEELING and AMBIENT temperatures have been widely discussed in linguistic research (e. g., Lehrer 1970; Prator 1963), with particularly consistent and accurate semantic analysis offered in Goddard and Wierzbicka (2007) and in FrameNet. The distinction between QUASI-REFERENTIAL and NON-REFERENTIAL AMBIENT temperatures is, basically, my addition: it has hardly been discussed in earlier research, but is well justified by cross-linguistic data, as will shortly become evident.

Curiously – and impressively – the fine-grained semantic analysis of the temperature terms mentioned above is in most cases based on English, where the semantic differences among the different frames of temperature evaluation are most often not reflected in either lexical or constructional differences: all the sentences in the English ex. (1) involve the same adjective *hot* in the same predicational construction. The same works for the two other most frequent adjectives – *warm* and *cold*. NON-REFERENTIAL AMBIENT temperatures are perhaps somewhat special here in obligatorily taking the dummy or ambient "it" as their subject (see Bolinger 1973 for the analysis of "it" in such cases).

Also in Wolof (Atlantic, Niger-Congo, nuc1347[3]), the two central temperature terms – the quality (stative) verbs *tàng* 'to be warm/to be hot' and *sedd* 'to be cold/to be chilly' – are used in the same way in all the frames of temperature evaluation, see ex. (2) (cf. Perrin 2015 on the temperature system in Wolof).[4]

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2 I have chosen the term "quasi-referential" rather than simply "referential" to signal that temperature evaluation in many of these cases applies to highly abstract entities, such as time periods, weather etc.

3 The abbreviation "nuc1347" refers to the unique and stable language identifier in Glottolog (https://glottolog.org), the so called "Glottocode". The references to all the languages in this study are provided with the corresponding Glottocodes.

4 Verbs in Wolof consist of an invariant lexical stem and an inflectional marker, classified as belonging to one of the non-focusing vs. focusing conjugations (Robert 2010: 470–471). In ex. (2) the verb stem attaches preposed *verb-focusing* markers indexing the person and number of the subject. Wolof does not require the presence of an overt subject in a clause, whose number and person is indexed by the verbal pronominal markers. The contrast between (2b) and (2c) shows the regular shift from the more concrete uses of quality verbs as predicated of particular entities to predications about meteorological (or, broader, ambient) events, which, in Wolof, involve indices for 3rd person singular and are incompatible with overt subjects (cf. Creissels et al. 2015: 38).

(2)   Wolof: temperature predication, constructions with quality verbs (Perrin 2015)

a. Tactile temperature: *Kafe bii dafa **tàng***.
coffee this 3sg.vf be.warm/be.hot
'This coffee is warm/hot.'
(Jean Léopold Diouf, p. c.)

b. Quasi-referential ambient: *Néeg bii dafa **tàng***.
room this 3sg.vf be.warm/be.hot
'This room is hot.'
(Perrin 2015: 165)

c. Non-referential ambient: *Dafa **tàng** ba ëpp*.
3sg.vf be.warm/be.hot until be.excessive
'It's excessively hot.'
(Perrin 2015: 166)

d. Personal-feeling: *Dama **tàng**!*
1sg.vf be.warm/be.hot
'I feel hot!'
(Perrin 2015: 166)

Languages like English or Wolof, which use the same central temperature lexemes in (almost) the same constructions for all the frames of temperature evaluation, are opposed to others, in which the frame-related distinctions have clear manifestations.

The Indo-Aryan language Palula spoken in Pakistan (phal1254) is a case in point (for details on the temperature term system, see Liljegren and Haider 2015). Palula makes a basic distinction between 'cold' and 'hot/warm'. However, for each of these values there is a *lexical split* between two different lexemes – a temperature adjective, involved in predications about TACTILE and QUASI-REFERENTIAL AMBIENT temperatures, and a temperature noun, involved in predications about NON-REFERENTIAL AMBIENT and PERSONAL-FEELING temperatures. Predications about TACTILE and QUASI-REFERENTIAL AMBIENT temperatures follow the standard morphosyntactic pattern of adjectival predication: in ex. (3), the TACTILE (and QUASI-REFERENTIAL AMBIENT) 'hot' is expressed by the adjective *táatu*/*téeti* in the nominative case, with or without a copula verb and agreeing with the subject in gender and number. The semantic difference between TACTILE and QUASI-REFERENTIAL temperatures in Palula is therefore not reflected in either lexical or constructional differences. In contrast to this, predications

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But ex. (2c) can also be interpreted as referring to tactile, quasi-referential and personal-feeling temperatures when the reference of the subject is clear from the context.

about NON-REFERENTIAL AMBIENT and PERSONAL-FEELING temperatures involve the unrelated noun *húluk*, but there is a radical *constructional split* between the two uses. NON-REFERENTIAL AMBIENT temperature is typically construed as an entity whose existence or coming into existence is stated, often in relation to a particular location or time (Liljegren and Haider 2015: 454), cf. ex. (3). Such constructions appear with or without an overt copula or with phrasal verbs like 'become'. Finally, in constructions for PERSONAL-FEELING temperatures, as in ex. (3d), the temperature noun is the subject of verbs like 'falling' and 'rising' and the Experiencer takes the non-nominative case, otherwise used for the expression of location or goal (Liljegren and Haider 2015: 455). Across the South Asian languages cases akin to these are well known as Dative Subject constructions, or, as *experiencer-as-goal constructions*, following Bickel (2004: 84–89).

(3)   Palula (Liljegren and Haider 2015)

    a. TACTILE: *pač, aní   čay   **téet-i.***
                                  ouch! this:NOM.F.SG tea[F] hot[A]-NOM.F.SG
                                  'Ouch! This tea is hot.'
                                  (Liljegren and Haider 2015: 450)

    b. QUASI-REFERENTIAL AMBIENT: *anú   kamrá **táat-u.***
                                    this:NOM.M.SG room[M] hot[A]-NOM.M.SG
                                    'This room is warm.'
                                    (Liljegren and Haider 2015: 452)

    c. NON-REFERENTIAL AMBIENT: *páar   bíiḍ-u   **húluk** de.*
                                    last.year much-NOM.M.SG heat[M] be:PST
                                    'It was very hot last year.' (lit. 'Last year there was much heat.')
                                    (Liljegren and Haider 2015: 458)

    d. PERSONAL-FEELING: *asaám **húluk** dít-u   de.*
                                    1PL.ACC heat[M] fall.PFV-MSG be:PST
                                    'We were feeling hot.' (lit. 'Heat had fallen on us.')
                                    (Liljegren and Haider 2015: 456)

The examples quoted above raise two different but interrelated questions that will be in the focus of the present paper:

1. How do the lexicon and grammar interact with each other in the expression of the distinctions among the different frames of temperature evaluation across languages?
2. How can this interaction be represented?

The languages considered in the paper come from the large-scale language sample (currently about 70 languages) for which the data have been systematically collected by means of questionnaires and dictionaries in close collaboration with experts and native speakers (cf. Koptjevskaja-Tamm 2015 for the details on the

methodology). For the purpose of this study, I have selected 27 languages to illustrate some of the interesting cases without any further requirements on how well they represent the world's languages. The languages and the sources of the data are listed in Table 4 (presented at the end of the paper).

I will focus on the central temperature terms, to the exclusion of the more marginal ones such as *scorching* or *tepid* that have a very restricted application. Languages vary as to how many temperature values they distinguish, i. e., whether they only have a binary distinction between 'hot/warm' vs. 'cold/cool' or have more elaborated systems (i. e., 'hot' vs. 'warm' vs. 'cold/cool', or 'hot' vs. 'warm' vs. 'cool' vs. 'cold'). This will not be discussed in the present study but will be visible in the tables and semantic maps for the different languages (cf. Koptjevskaja-Tamm 2015 for the argumentation behind these distinctions).

2 The challenge of creating a semantic map for the temperature domain

In my earlier work (Koptjevskaja-Tamm 2011; 2015: 17), I have suggested that the cross-linguistically recurrent patterns in how languages distinguish among the frames of temperature evaluation by lexical means can be captured in a semantic map like the one in Figure 1. Figure 2 shows how five different languages carve up this semantic space lexically for either 'cold' (Modern Eastern Armenian, Kamang and Japanese) or 'hot/warm' (Palula and Wolof).[5] As evidenced by Figure 2, none of the five different language-specific configurations violate *the connectivity hypothesis*, according to which "any relevant language-specific and construction-specific category should map onto a CONNECTED REGION in conceptual space" (Croft 2001: 96). The main generalization is that PERSONAL-FEELING temperatures are often singled out by languages, whereas the linguistic encoding of ambient temperature may share properties with those of either TACTILE or PERSONAL-FEELING temperature.

Semantic maps like those in Figure 1 and Figure 2 look like regular semantic maps for the purposes of lexical typology, which show how a certain cognitive domain (e. g., COLOUR, PERCEPTION, BODY) is carved up by (central) words,

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5 Importantly, linguistic temperature systems are often heterogeneous and may consist of several subsystems, with the consequence that the different temperature values (like 'hot' and 'cold') even within one and the same languages may sometimes differ in their lexical and constructional distinctions.

| TACTILE (TACT) | — | QUASI-REFERENTIAL AMBIENT (AMB_QR) | — | NON-REFERENTIAL AMBIENT (AMB_NR) | — | PERSONAL-FEELING (PF) |

Figure 1: The General Semantic map for the temperature domain.

| *saŕn* TACT | *c'urt* AMB_QR   AMB_NR | *mrsum* PF |

Modern Eastern Armenian:'cold'

| *kamal* TACT   AMB_QR   AMB_NR | *faatei* PF |

Kamang: 'cold'

| *tsumetai* TACT | *samui* AMB_QR   AMB_NR   PF |

Japanese: 'cold'

| *táatu/téeti* TACT   AMB_QR | *húluk* AMB_NR   PF |

Palula: 'hot/warm'

| TACT | *tàng* AMB_QR   AMB_NR   PF |
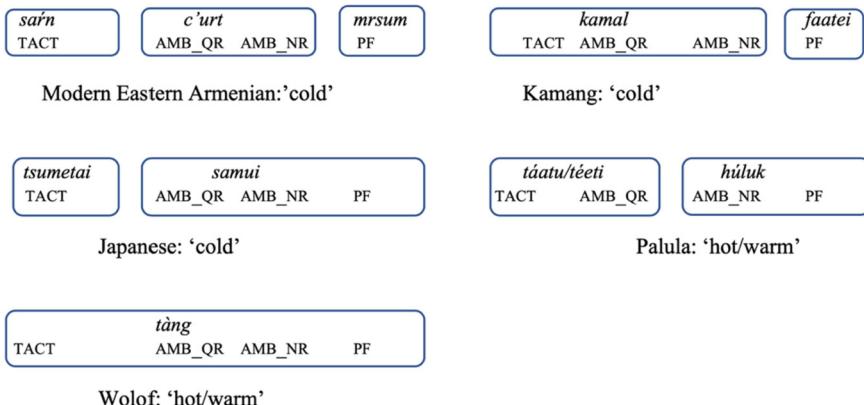
Wolof: 'hot/warm'

Figure 2: Words for 'cold' in Armenian (Indo-European), Kamang (Timor-Alor-Pantar), and Japanese; 'hot/warm' in Palula (Indo-European) and Wolof (Niger-Congo). (TACT = TACTILE, PF = PERSONAL-FEELING, AMB_QR = QUASI-REFERENTIAL AMBIENT, AMB_NR = NON-REFERENTIAL AMBIENT) (modified from Koptjevskaja-Tamm 2015: 17).

ideally belonging to the same word class (cf. Koptjevskaja-Tamm et al. 2015, Georgakopoulos et al. 2016, and Rakhilina et al. 2022 on semantic maps in lexical typology). Translated into François' (2008) terminology, such maps reflect patterns of *colexification* by visualising which concepts are associated with one and the same word.

François (2008) suggests further to distinguish between *strict colexification*, defined on the basis of identity of forms in synchrony, and *loose colexification*, which covers relatedness of forms encoding two concepts from a diachronic point of view as well as cases of partial identity of forms, for instance, in derivation or compounding. For instance, the two 'hot/warm' words in Palula (*táatu*/*téeti* vs. *húluk* are not formally related at all, while the 'cold' adjective and noun (*šidáalu* vs. *šid*) are clearly related, at least diachronically. Thus, as shown in Figure 3, Palula *strictly* colexifies the concepts 'tactile cold' and 'quasi-referential cold' by *šidáalu*, and 'non-referential ambient cold' and 'personal-feeling cold' by *šid*, but *loosely* colexifies 'quasi-referential cold' and 'non-referential cold' by *šidáalu* vs. *šid*. In other words, even the non-identical temperature words used for different
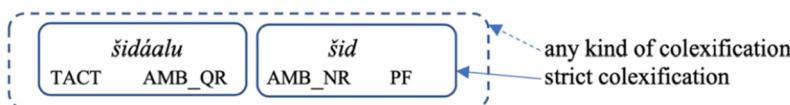
Figure 3: Words for 'cold' in Palula.
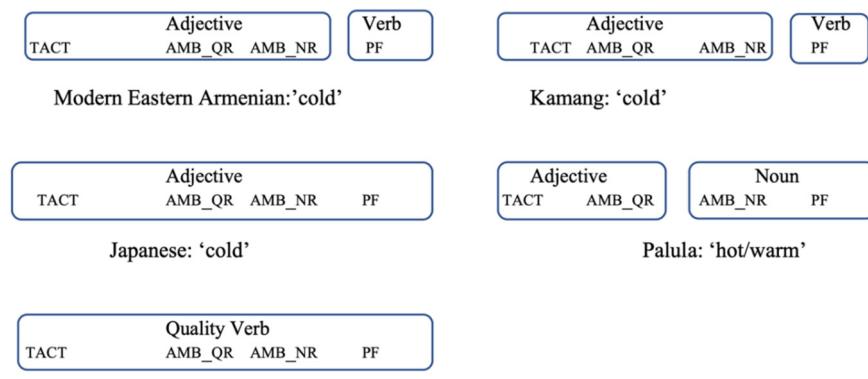
Figure 4: Word-class affiliation of the words for 'cold' in Modern East Armenian, Kamang, Japanese, Palula and Wolof.

functions can differ in their *formal relatedness*, or *motivational patterns* (Koch 2001), i. e., whether they are completely unrelated or are related via derivation (synchronically or diachronically).

The problem is, however, that for the temperature domain the lexical and grammatical/constructional distinctions are often inseparable from each other. As we have seen in ex. (3) in Section 1, the two 'hot/warm' words in Palula differ in their word-class affiliation (adjective vs. noun) and are used in very different constructions, and the same goes for the two 'cold' words in Figure 3. Likewise, the PERSONAL-FEELING 'cold' in both Modern Eastern Armenian and Kamang is a verb, whereas the other 'cold' words are adjectives. Figure 4 shows how the same semantic space as in Figure 2 (of 'cold' or 'warm/hot') is organized in the same five languages, but this time in terms of different word classes. The resulting configurations, again in accordance with the connectivity requirement, are fewer than those in Figure 2 with the result that Modern Eastern Armenian and Kamang share the same pattern, and the same goes for Japanese and Wolof.

Finally, when constructional similarities are taken into account, the corresponding semantic maps will again differ and unveil still other cross-linguistic

similarities and dissimilarities. For instance, as shown in ex. (3) in Section 1, Palula has three radically different constructions for the different frames of temperature evaluation, whereas in Modern East Armenian (not exemplified here), the NON-REFERENTIAL AMBIENT construction is closely related to the one used for TACTILE and QUASI-REFERENTIAL AMBIENT predications.

To sum up, already these examples testify to an intricate picture of how different linguistic means interact with each other in carving up the same semantic domain and expressing the relevant categories. But how exactly is this *joint linguistic expression* of categories carried out across languages? In other words, is there any systematicity in this interaction? Or, to quote Evans (2010), "how do semantic choices made in one subsystem affect those in others?"

These questions are in fact quite problematic, seen against the background of the customary division between lexical and grammatical typology. Grammatical behavior of words and morphosyntactic patterns as encoding meanings traditionally belong to grammatical typology, which normally disregards the details related to lexical choice. For lexical typology, on the other hand, lexical choice is of primary interest, but the grammatical behavior of the relevant lexical expressions lies normally outside of its scope. This is all the more unfortunate given that both grammatical and lexical typology share much of their methodology, including ample use of semantic maps for representing their generalizations (cf. Georgakopoulos and Polis 2018 for an excellent overview).[6]

However, this problem has been noticed earlier and linguistic literature has several suggestions on how to reconcile description, analysis and representation of both lexical, grammatical and syntactic information cross-linguistically. One promising direction starts from the methodology of semantic maps and enrichens them with constructional information, as this is done in the comparison of the uses of manner demonstratives in Kambaata (Cushitic) and Wan (Mande) in Nikitina and Treis (2020), and in the semantic comparison of the words for 'grain' and their relatives across South Mande in Nikitina (2022).

Another direction starts from the framework elaborated in constructional approaches to language, which reject the idea of compartmentalization in linguistic analysis, including the sharp distinction between lexicon and grammar, and

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6 Not surprisingly, this is also the case in most of the contributions to this volume: e. g., Rakhilina et al. (2022), and François (2022) deal exclusively with wholesale content lexemes, without considering their grammatical behaviour and the constructions in which they are used, while Vanhove (2022) is interested in the grammatical markers, without considering lexical semantics. And while Levshina (2022) and Becker and Malchukov (2022) discuss issues on the crossroads between lexicon and grammar (morphology and constructions), they do not spell out how the details of this interaction can be captured and represented.

consider every kind of conventionalized pairings of meaning and expression as constructions (Croft 2001; Goldberg 1995; 2006). However, most of the research in constructional grammar has so far been very language-specific, with the cross-linguistic research restricted to morphosyntactic patterns (Croft 2001, to appear). Koch (2012) offers a major consistent attempt to apply a constructional approach to the cross-linguistic analysis of joint linguistic expression of a semantic space, in this case LOCATION–EXISTENCE–POSSESSION. What makes this "super-domain" particularly interesting and directly comparable to the temperature domain is that its encoding involves an intricate interaction between lexical and morphosyntactical means. For instance, while the verb *ter* 'to have' in Brazilian Portuguese jointly lexicalizes POSSESSION and EXISTENCE, the latter meaning is encoded by an impersonal construction, as opposed to the normal subject-predicate construction for POSSESSION, cf. *o rapaz **tem** um livro* 'The boy has a book' vs. ***tem** um livro*. These aspects have been to a certain extent downplayed in the rich earlier cross-linguistic research on LOCATION-EXISTENCE-POSSESSION, which has been partly split between the studies primarily interested in joint lexicalization and those primarily dealing with morphosyntactic patterns. Koch (2012) sets out to demonstrate how Construction Grammar can be utilized to provide an integral account for the complex lexicon-grammar interaction, or "constructional typology" in a sample of nineteen genetically and areally diverse languages.

My own proposal to integrate the traditions of grammatical and lexical typology, elaborated in the rest of this paper, is reminiscent of the one in Nikitina and Treis (2020) and in Nikitina (2022) in using semantic maps and enriching them with grammatical and constructional information. On the other hand, it pays more attention to the structural similarities between the constructions (building on the notion of *inheritance*), much in the spirit of Koch (2012). In what follows I will examine a few cases in which different linguistic means interact in carving up the temperature domain and reflect on how these can be captured by means of elaborated semantic maps.

I will start from the grammatical typology, i. e., from the constructions used for the three kinds of temperature predications, with constructions for PERSONAL-FEELING temperatures as pivotal for the ensuing discussion. These will be introduced in Section 3.[7] In Sections 4 and 5, I will focus on languages with two particular groups of constructions for PERSONAL-FEELING temperatures and investigate how these relate to the constructions used for the other frames of temperature evaluation and to the choice of the temperature term involved in them. To account for these relations, I will introduce an elaborated model of semantic maps with

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7 Note that attributive constructions will largely be left out from consideration.

three layers – the layer specifying the words with the information on their mutual formal relations (i. e., whether they are identical, completely unrelated or related via derivation or inflection), their morphosyntactic properties (e. g., their part-of-speech affiliation, inflectional potential, etc.), and the constructions they occur in. Section 6 will conclude the article.

3 Constructions for temperature predications

As announced in Section 1, one of the main goals of this paper is to try to understand how the lexicon and grammar interact with each other in the expression of the distinctions among the frames of temperature evaluation across languages. A crucial question in this connection is which types of predicative constructions for the different functions (i. e., for the different frames of temperature evaluation) may co-exist within one and the same language, and/or whether these involve the same or different lexical items. This is the question which I want to explore in the rest of this paper.

Predicative constructions of various kinds have been of central concern for grammatical typology. There are several typologies of *property predications*, where the main focus has been on the extent to which these align with verbal, existential, nominal and locational predications (cf. Hengeveld 1992; Wetzer 1996; Stassen 1997; Pustet 2003). Cross-linguistic research on *experiencer constructions*, including constructions for bodily sensation, is relatively rich but less systematic. One of the pertinent issues here is to what extent experiencers are encoded as (canonical) agent-like subjects or appear as datives or as patients (e. g., Aikhenvald et al. 2001; Bhaskararao and Subbarao 2004). Reh (1998) suggests a framework for capturing cross-linguistic variation in experiential constructions and applies it in the brief descriptions of a few African languages. Reh's framework is further elaborated in Verhoeven's (2007) detailed study of experiential constructions in Yucatec Maya. Systematic cross-linguistic research on *ambient constructions* is relatively limited, apart from Eriksen et al. (2010), who propose a general typology for capturing the cross-linguistic variation in weather expressions with the main focus on precipitation constructions, and scattered descriptions and mentions in connection with impersonal constructions (e. g., in Malchukov and Siewierska 2011).

In general, studies focusing on constructions used for property, experiencer and ambient predications are normally restricted to one of these functions and have hardly anything to say about its potential links to the others. This is understandable given that very few concepts can be found in more than one of the

three functions. Pustet (2015) is noteworthy in zooming in on the constructions that apply to the lexical expressions coming from the same domain of temperature, but used in different functions. Since constructions for TACTILE predications are unremarkably uniform in having the entity whose temperature is evaluated as the subject of the intransitive temperature predicate, Pustet focuses on PERSONAL-FEELING (experiencer) and NON-REFERENTIAL AMBIENT temperatures. She suggests typologies for both, but taking each of the functions per se. As a result, the two typologies are neither directly commensurable with each other nor sufficiently fine-grained for providing answer to the question of which types of constructions for the three functions may co-exist within one and the same language, and/or whether these involve the same or different lexical items.

In the following, I will make use of Pustet's observation that PERSONAL-FEELING temperatures show the greatest cross-linguistic variation in their constructional patterns as compared to both AMBIENT and TACTILE temperatures. I will ask whether the choice of a particular construction for PERSONAL-FEELING temperatures has consequences for the choice of constructions for QUASI-REFERENTIAL and NON-REFERENTIAL AMBIENT temperatures and/or for the lexical distinctions between the temperature terms used in the four functions. My point of departure will therefore be a classification of PERSONAL-FEELING temperature constructions, largely inspired by both Verhoeven (2007) and Pustet (2015), as presented in Table 1.

The two organizing parameters in Table 1 are the valency of the main predicate (intransitive vs. transitive) and the grammatical subject of the construction, or "the goal of orientation" (Verhoeven's term). PERSONAL-FEELING constructions can thus be *Experiencer-oriented*, *Expertum-oriented* (i. e., having the sensation/feeling, in this case temperature, as the subject), and *Non-oriented* (i. e., lacking a subject or having an ambient/"dummy" subject) constructions.[8] Relating to the examples quoted so far, PERSONAL-FEELING predications in both English (ex. (1b)) and Wolof (ex. (2d)) follow the Experiencer-oriented intransitive strategy, with temperature adjectives in English and temperature verbs in Wolof, whereas PERSONAL-FEELING predications in Palula (ex. (3d)) use the Expertum-oriented intransitive strategy involving temperature nouns, the motion verbs 'rise'/'fall' and the Experiencer as the non-core argument. The German example *Mir ist kalt* lit. 'To_me is cold' illustrates the Non-oriented intransitive strategy.

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8 The two other orientations suggested in Verhoeven (2007: 71–72) are Body-part orientation and Stimulus-orientation. Stimulus-orientation is very marginal for the temperature domain. Body-part orientation, although relevant for the temperature domain, will not be considered here.

Table 1: A typology of construction types used for personal-feeling temperatures inspired by Pustet (2015) and Verhoeven (2007: 71–72) (EXPr = Experiencer, TempN = temperature noun).

	Intransitive strategies			Transitive strategies		
	Intrans. Subject	Non-core argument	Predicate	Transitive Subject	Object	Predicate
Experiencer-oriented	EXPr		Intransitive temperature denoting predicate (verbal and non-verbal)	EXPr	TempN	'feel', 'have', 'see', etc.
Expertum-oriented	TempN	EXPr	copula; 'come'	TempN	EXPr	'do', 'hit', 'touch', 'bite', etc.
Non-oriented	Non-referential/ No subject	EXPr	Intransitive temperature denoting predicate (verbal and non-verbal)	Non-referential/ No subject	EXPr	Transitive temperature denoting verb

In the next two sections I will focus on two groups of languages: those in which PERSONAL-FEELING temperature predications involve temperature nouns (as in Palula), and those in which PERSONAL-FEELING temperature predications follow the Non-oriented intransitive strategy (as in German). I will present an array of cases to show the interplay between constructional and lexical choices and discuss how these constructional and lexical similarities and distinctions can be captured in semantic maps. In the rest of the paper, I will use the abbreviations TACT, AMB_QR, AMB_NR and PF for TACTILE, QUASI-REFERENTIAL AMBIENT, NON-REFERENTIAL AMBIENT and PERSONAL-FEELING temperatures, respectively.

4 Languages in which constructions for personal-feeling temperature predications involve temperature nouns

Table 1 contains three different construction types pertaining to PF temperature and involving temperature nouns – two Expertum-oriented strategies and the Experiencer-oriented transitive strategy. As already mentioned, Palula ex. (3d) illustrates the intransitive Expertum-oriented strategy. Ex. (4) from Likpɛ (Sɛkpɛlé) (sekp1241), a Kwa language spoken in West Africa, shows the transitive Expertum-oriented strategy with the verb 'hold', while ex. (5) from Maltese (malt1254), an Arabic (Semitic) language spoken in Malta, follows the transitive Experiencer-oriented strategy with the verb 'feel' taking the temperature noun (with or without the definite article) as its object.

(4)   TRANSITIVE EXPERTUM-ORIENTED PF: Likpɛ (Sɛkpɛlé) (Ameka 2015: 48)
      lɛ-yɔ   *lɛ́*   *mɛ*
      CM-cold   hold   1SG
      'I am feeling cold' (lit. 'Cold is holding me')

(5)   TRANSITIVE EXPERIENCER-ORIENTED PF: Maltese (Michel Spagnol p. c.)
      Qed   *in-ħoss*   ***(is)-sħana***
      PROG   1SG.IPFV-feel   DEF-heat
      'I am feeling the heat'

Table 2 (presented at the end of the paper) displays the constructions and the temperature words used for TACT, AMB_QR, AMB_NR and PF predications in a sample of ten languages in which PF constructions involve temperature nouns.

Now, knowing that PF predications in a language are based on temperature nouns, can we draw any further conclusions on the properties of the linguistic expressions involved in the encoding of the temperature domain in the language? There are at least three groups of further questions to ask here – questions about the morphosyntactic properties of the temperature words, their formal relatedness, and the constructions used for the different frames of temperature evaluation and the relations among them. These three groups of questions correspond to the three layers in semantic maps, as will be elaborated in the rest of this paper.

First, there are further questions related to the **morphosyntactic properties of the temperature words**, such as whether the use of a temperature noun in PF predications has implications for the word-class affiliation of the temperature term(s) involved in predications for the other frames of temperature evaluation.

Clearly, given that TACT and AMB_QR predications are normally based on adjectives or on stative verbs, there will be a radical word-class split between the temperature terms involved in them, on the one hand, and in PF predications, on the other. But what about AMB_NR predications?

The data in Table 2 seem to suggest the following generalization:

> If a language has a PF predication based on a temperature noun, it also has an AMB_NR predication based on the same noun.

The use of temperature nouns in both PF and AMB_NR predications is shown in ex. (3c)–(3d) from Palula, ex. (4) and (6) from Likpɛ (Sɛkpɛlé) and ex. (5) and (7) from Maltese.

(6) AMB_NR predication: Likpɛ (Sɛkpɛlé) (Ameka 2015: 48)
  lɛ-yɔ   *kpé*
  CM-cold be.in
  'It is cold'

(7) AMB_NR predication: Maltese (Michel Spagnol p. c.)
  hawn   ***is-sħana.***
  here (there.is) DEF-heat
  'It is hot.'

The reverse is not true, as shown in ex. (8) from Modern Greek, which uses temperature nouns in the accusative case as the object of an impersonal transitive verb 'make/do' in AMB_NR predications (ex. (8c)), but temperature verbs in PF predications (ex. (8d)) (and temperature adjectives in both TACT and AMB_QR predications, ex. (8a)–(8b)).

(8)   Modern Greek (Stathi 2015: 379)

     a. TACTILE: *i*   *pétres*   *íne*   *zest-és*

                            DEF.F.NOM.PL stone.F.NOM.PL be.PRS.3 hot-F.NOM.PL

                            'The stones are hot.'

     b. QUASI-REFERENTIAL AMBIENT: *o*   *ánemos*   *íne*   *zest-ós*

                            DEF.M.NOM.SG wind.M.NOM.SG be.PRS.3 hot-M.NOM.SG

                            'The wind is hot.'

     c. NON-REFERENTIAL AMBIENT: *kán-i*   *zésti*   *edhó*

                            make-PRS.3SG heat.F.ACC.SG here

                            'It is hot here.' (lit. 'It makes heat here')

     d. PERSONAL-FEELING: *zesténome*

                            feel.hot.PRS.1SG

                            'I am hot.'

The semantic map in Figure 5 visualizes the above generalization in terms of the morphosyntactic properties of the temperature term involved in the predications for the different frames of temperature evaluation, whereas Figure 6 shows the corresponding morphosyntactic map for Modern Greek.

    Second, there are questions pertaining to the choice of the temperature words themselves and their **formal relatedness**, or motivational patterns, i. e., the extent to which the terms are related to each other in their form, mirroring their conceptual relatedness (Koch 2001). All the ten languages in Table 2 use the same temperature noun in both AMB_NR and PF predications, but show an interest-
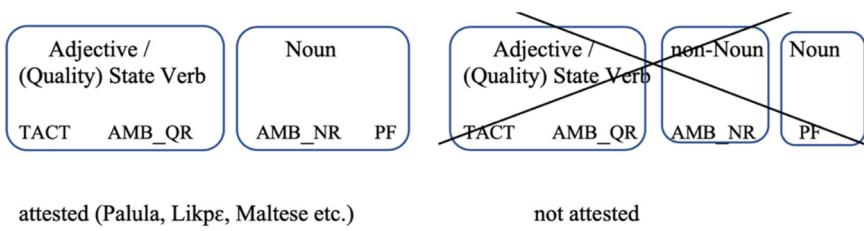

Figure 5: The morphosyntactically based semantic map for the temperature predications in languages in which PF predications involve temperature nouns.

Figure 6: The morphosyntactically based semantic map for the temperature predications in Modern Greek.

ing cross-linguistic variation when it comes to its formal relatedness to the corresponding adjective/stative verb.

To start with, there are cases where the adjective/stative verb and the corresponding noun for the same temperature value are not formally related at all. This is found in such examples as 'hot' in Palula (*táatu* vs. *húluk*), but also 'hot' and 'cold' in Bamana[9] (*kálan* or *gòni* vs. *fùnténi* 'hot', and *súma* vs. *nénε* 'cold'), in Ewe[10] (*xɔ dzo/dze dzo* vs. *afífiá* 'hot', and *fá* vs. *avuvɔ* 'cold') and in Likpε (*yila* vs. *lí-wi* 'hot', and *yúə* vs. *lε-yɔ* 'cold').

Next there are cases in which the temperature adjective and the temperature noun are clearly related, as in 'cold' in Palula (*šidáalu* vs. *šid*), 'hot' in Spanish (*caliente* vs. *calor*), 'hot' and 'cold' in Hindi (*garam* vs. *garmii* 'hot', and *thaṇḍaa* vs. *thaṇḍ* 'cold) and in Maltese (*sħun* vs. *sħana* 'hot', and *kiesaħ* vs. *ksieħ* 'cold), and 'hot', 'warm' and 'cold' in Algerian Arabic (*sxun* vs. *sxana* 'hot', *dafi* vs. *dfa* 'warm', and *barəd* vs. *bərd* 'cold'). In François' (2008) terms, these are all examples of loose colexification.

Finally, there are cases like Italian 'hot' (*caldo*) and 'cold' (*freddo*) and Spanish 'cold' (*frío*), where the same form is used in all constructions, the only difference being the presence of gender-number agreement in the TACT and AMB_QR uses. There are therefore no clear indications as to the word-class status of the forms used for AMB_NR and PF predications, apart from their uses in typical nominal functions as direct objects to the verbs 'make/do' and 'have', which they share with obvious nouns such as 'day' or 'hunger' in other ambient predications and experiential predications about bodily sensations. Importantly, all the three words have other typically nominal uses (e. g., Luraghi 2015: 338–339 treats *caldo* and *freddo* in Italian as both nouns and adjectives). It is therefore not too far-fetched to treat these examples as adjective-to-noun conversion, i. e., a special case of derivation, and loose, rather than strict colexification in François' (2008) terms, and to analyze AMB_NR and PF predications as nominal.

Figure 7 elaborates the simple semantic map in Figure 5 based on the morphosyntactic properties of the temperature words involved in the different predications, by including an additional layer representing the formal relatedness between them. Here the 'cold' noun and adjective/stative verb stretch between being completely unrelated (in Bamana) via clearly related by an explicit derivational marker (in Maltese) to being related via conversion (and having basically the same form) (in Italian).

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9 Bamana (bamb1269) is a Mande language spoken in Mali.
**10** Ewe (ewee1241) is a Kwa language spoken in Ghana and Togo.
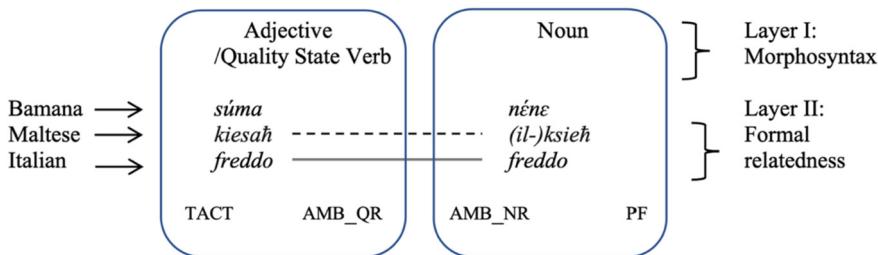
Figure 7: A two-layered semantic map for temperature predications for 'cold' containing information both on the morphosyntactic properties of the temperature words involved in them and on the formal relatedness between them (W_1 - - W_2 – the words W_1 and W_2 are formally related by an explicit marker, W_1 — W_2 – the words W_1 and W_2 are related by conversion, W_1 W_2 – the words W_1 and W_2 are not formally related).

Finally, there are questions on the **constructions** used for the different frames of temperature evaluation and the **relations** among them: are the constructions completely different, identical or in one or another way related to each other? Again, AMB_QR predications and TACT predications normally share the same construction (the standard adjectival or stative verb construction), so what primarily varies is the relation between AMB_NR predications and PF predications.

In some languages these two types of temperature predication may resort to completely different constructions. Palula presents such a case: as explained in connection with ex. (3) in Section 1, AMB_NR predication is basically an existential construction with or without an overt copula or with phrasal verbs like 'become', while PF predication involves an intransitive Expertum-oriented construction with verbs like 'falling' and 'rising' and experiencer marked with the Dative case.

In addition, there are also languages in which AMB_NR and PF predications are clearly related. In Bamana, AMB_NR predications also have the form of an existential construction (ex. (9a)). However, when the same construction is further expanded by a prepositional phrase with the locative/possessive marker, it is used for expressing both possession and PF predication (ex. (9b)). Ewe shows another version of a very close similarity between AMB_NR and PF constructions in that both involve the verb 'do/happen', used intransitively for AMB_NR (ex. (10a)) and transitively for PF temperatures (ex. (10b)).

(9)   Bamana (Valentin Vydrin p. c.)
      a. AMB_NR predication: *Fùnténi-`bɛ́*   (*yèn*).
                             heat-DEF COP here
                             'It is hot here.'
      b. PF predication: *Fùnténi-`bɛ́ ŋ́   ná.*
                             heat-DEF COP 1SG POSTP
                             'I feel hot.'

(10) Ewe (Ameka 2015: 63)
      a. AMB_NR predication: *avuvɔ le   wa-wǎ*
                             cold   be.at:PRES RED-do:PROG
                             'It is hot here.' (lit. 'cold is doing/happening')
      b. PF predication: *avuvɔ le   wa =m̌*
                             cold   be.at:PRES do=1SG:PROG
                             'I am (feel) cold.' (lit. 'cold is doing/happening to
                             me')

In terms of constructional approaches to language, further elaborated in Koch's (2012) "constructional typology", the two constructions in each of the examples (9) and (10) are related via *inheritance links*. Inheritance links are the constructional correspondence to the notion of formal relatedness, operating on the lexical level. In this terminology, the AMB_NR constructions in both Bamana and Ewe are related to the corresponding PF constructions via a *subpart link*, which is one of the four types of inheritance links in Goldberg's (1995) model.

Figure 8 captures the information on the relations among the constructions involved in temperature predications in Palula by adding a third, *constructional*, layer to the morphosyntactic layer and the formal-relatedness layer and spelling out the details both for the lexical items and for the constructions.

Figure 9 gives a more schematic and succint representation of the situation in Bamana and Ewe by using the abbreviations W_n and Cx_n instead of concrete lexical items and concrete constructions (and omitting the specification of the layers themselves). The arrow from Cx_3 to Cx_2 shows that Cx_2 is related to Cx_3 via an inheritance link.

In the languages listed in Table 2, the situation captured by Figure 9 is relatively infrequent. In other words, it seems that in languages that use the same temperature noun in both AMB_NR and PF predications tend to use them in very different constructions (i. e., not related to each other), but the basis for this observation is currently limited.

In Section 5, I will apply the same method to compare and represent temperature predications in some of the languages in which PF follow the Non-oriented intransitive strategy. In languages of this kind, PF and TACT predications involve
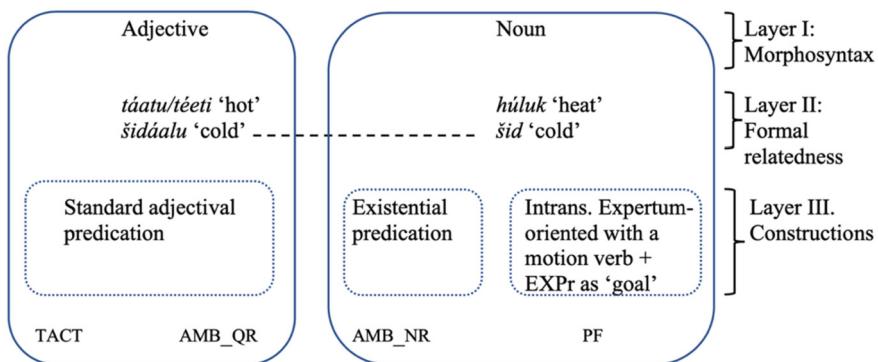
Figure 8: The detailed three-layered semantic map for temperature predications in Palula.
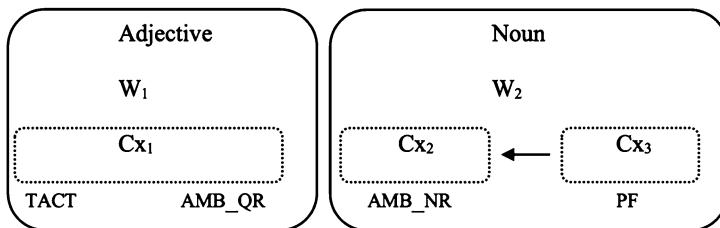
Figure 9: The schematic three-layered semantic map for temperature predications in Bamana and Ewe.

temperature terms that do not (necessarily) differ in their word-class affiliation, but may still differ in their morphosyntactic properties, which makes them different from the cases considered in this section.

5 Languages in which personal-feeling temperature predications follow the Non-oriented intransitive strategy

Table 3 (presented at the end of the paper) surveys the constructions and the temperature words used for TACT, AMB_QR, AMB_NR and PF predications in a sample of 14 languages where PF constructions follow the Non-oriented intransitive strategy. Although the current sample is largely restricted to the Indo-European

and Uralic languages (with the addition of one Turkic language, Bashkir), similar constructions are attested elsewhere (for examples see Pustet 2015).

As explained in Section 3 (cf. Table 1 and the text introducing it), Non-oriented PF constructions lack subjects or have an ambient (alt. dummy) subject. Their intransitive version involves an intransitive temperature denoting predicate, either verbal or non-verbal, and the Experiencer encoded as the non-core argument, typically in the Dative case (or with the marker having similar functions). Again, even though sharing the defining properties, the relevant constructions and the properties of the words involved in them are not the same across languages. In order to understand and represent the cross-linguistic variation in this case I will follow here the same procedure as in the preceding section and ask questions pertaining to three different levels of linguistic analysis – morphosyntax, formal relatedness, and constructions.

Examples (11)–(13) show slightly different versions of the contrast between the standard adjectival predication for TACT and AMB_QR temperatures, and the Non-oriented intransitive strategy for PF temperatures, with the focus on the **morphosyntactic properties** of the temperature terms involved in them.

First of all, there are languages like Komi-Permyak (komi1269) and Komi-Zyrian (komi1268), both Uralic, in which the temperature term for 'cold' in both TACT and PF uses appears in exactly the same form, basically because adjectives lack agreement (ex. (11)). In other words, there is **no morphosyntactic distinction** between the temperature terms used in these two frames of temperature evaluation.

(11)   Komi-Permyak (Ladygina 2012)

      a. TACTILE: *Ju-as*   *va-ïs*   ***ködzyt***

                                   river-LOC.POSS3SG water-POSS.3SG cold

                                   'The water in the river is cold.'

      b. PERSONAL-FEELING: *Mujkö*   *menïm* ***ködzyt***

                                     somehow I.DAT   cold

                                     'I am somehow a bit cold.'

The Komi case is contrasted to the Polish situation, illustrated in ex. (12). In Polish, as in all Slavic languages, PF temperatures are expressed by an impersonal construction involving the default form of the copula (3rd person singular for nonpast and neuter singular for past) and the form called "adverb" or "predicative" in the Slavic linguistic tradition (Ru *kategorija sostojanija*). The temperature terms in two uses are therefore traditionally conceived of as being derivationally related, but belonging to two different word classes, which means that there is **a clear morphosyntactic split** between the temperature terms involved in TACT and AMB_QR predications, on the one hand, and those involved in PF predica-

tions, on the other. However, as will be discussed later in this section, the decision to treat predicatives as a separate word class is not straightforward.

(12) Polish (Marcin Włodarczak p. c.)
    a. TACTILE: *Wod-a*   *jest* **ciepł-a.**
                          water-NOM.SG is   warm-F.SG.NOM
                          'The water is warm.'
    b. PERSONAL-FEELING: *Był-o*   *mi*   **ciepł-o.**
                          was-N.SG me.DAT warm-PRED.
                          'I felt warm.'

Finally, in Icelandic, the TACT (and AMB_QR) and the PF involve the same temperature adjectives, but with different morphosyntactic properties. Adjectives in the standard predicative construction appear in the nominative case and agree with the subject in gender and number, whereas PF temperatures are expressed by impersonal constructions with the 3rd person singular of the copula and the default (neutral singular) form of the temperature adjective (ex. (13)). In other words, the temperature terms in the two uses have **different inflectional potential**, with the temperature adjective in PF constructions being restricted to just one form.

(13) Icelandic (Elisabet Eir Cortes p. c., Pétur Helgason p. c.)
    a. TACTILE: *Stein-ar-nir*   *eru* **kald-ir.**
                          stone-NOM.PL-DEF.PL.NOM are cold-F.PL.NOM
                        'The stones are cold.'
    b. PERSONAL-FEELING: *Mér*   *er* **kalt**.
                          I.DAT is cold.N.SG.NOM
                          'I feel cold.'

The pattern illustrated in ex. (11), whereby Non-oriented intransitive PF predications and TACT predications involve the same uninflected adjective, is relatively rare in the languages represented in Table 3. In most cases there is a clear morphosyntactic difference between the two forms (PF temperatures are expressed by a default form of the adjective, as opposed to the agreeing forms used for TACT, as in ex. (13), or by a form, derivationally related to it, as in ex. (12)). Moreover, the form used for PF temperatures is also used for AMB_NR predications, confirming the pattern discussed in Section 4.[11] This is illustrated in (14) (cf. ex. (10b), (11b), and (12b)).

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[11] Both Latvian and Finnish allow two different forms for the temperature term in AMB_NR predications, of which only one occurs in PF predications. This is, however, in line with the pattern mentioned here, since the form used in PF predications is also allowed in AMB_NR predications.
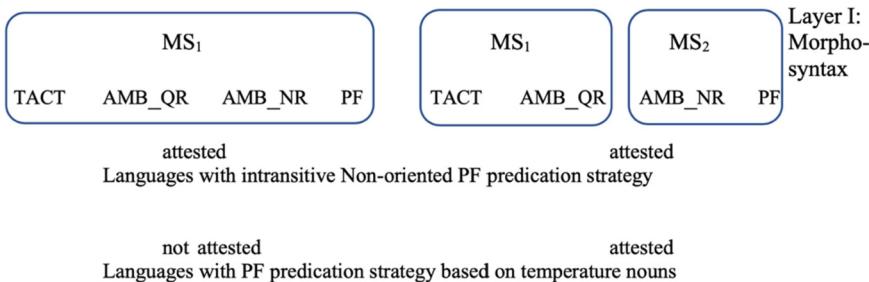
Figure 10: A schematic morpho-syntactic semantic map for temperature predications in Sections 4 and 5 (MS$_n$ – a form with specific morphosyntactic properties).

(14)   NON-REFERENTIAL AMBIENT temperatures
a. Komi-Permyak (Ladygina 2012)
*Rït-tez-nas   **ködzyt***
evening-PL-INSTR.3SG cold
'It is cold in the evening.'
b. Icelandic (Elisabet Eir Cortes p. c., Pétur Helgason p. c.)
*Það er **kalt**   í   dag.*
that is cold.N.SG.NOM in day.
'It is cold today.'
c. Polish (Marcin Włodarczak p. c.)
*W pokoj-u   był-o   **ciepł-o.***
in room-LOC.SG was-N.SG warm-PRED
'It was warm in the room.'

However, on the whole, the morphosyntactic variation within temperature predication in languages with the intransitive Non-oriented PF strategy is more varied than in the cases considered in the preceding section, which always have a radical word-class split between the temperature terms involved in TACT and AMB_QR predications (temperature adjectives/stative verbs), and those involved in AMB_NR and PF predications (temperature nouns). Figure 10 compares the morphosyntactically based configurations attested in the languages in the two groups.

Let's now turn to the **constructions** used for the different frames of temperature evaluation and the **relations** among them. In the majority of the languages in Table 3, the constructions used for PF and AMB_NR predications are clearly related, differing only in the presence of the experiencer marked with the Dative case or with its language-specific equivalent. In other words, the AMB_NR constructions in these languages are related to the corresponding PF construc-
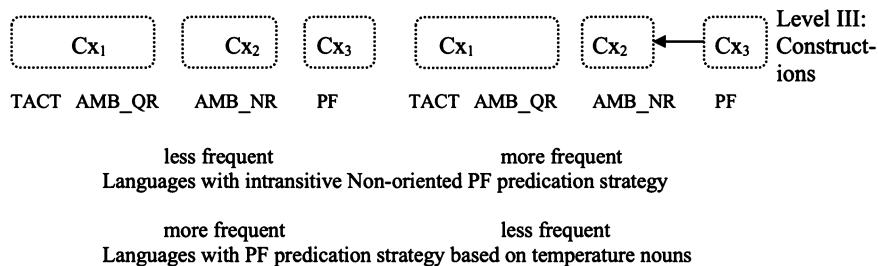
Figure 11: A schematic construction-based semantic map for temperature predications in Sections 4 and 5 (Cx_n – a specific construction).

tions via a subpart (inheritance) link. The only exceptions here are German and Icelandic, which have the ambient/dummy subject *es*/*þat* in AMB_NR predications (Bolinger 1973; Malchukov and Ogawa 2011: 25), as opposed to the subjectless impersonal PF predications, cf. ex. (13b) and (14b). In these two languages, the AMB_NR predications can be analyzed as being a particular instance of the standard adjectival predication (cf. ex. (13a)), used for both TACT and AMB_QR evaluation, i. e., being linked to it via an *instance* (inheritance) link in the Goldberg/Koch model. In other words, the situation here is in a way opposite to the one considered in Section 4, where constructions used for TACT/AMB_QR, AMB_NR and PF predications in most of the languages were not related to each other. Figure 11 compares the two constructionally based configurations attested for the languages of the two groups (i. e., those considered in this section and in Section 4).

Finally, when it comes to the temperature words themselves and to their formal relatedness, or motivational patterns, the patterns found here also parallel those considered in Section 4. In other words, as shown in Table 3, the temperature words in PF and AMB_NR vs. TACT predications stretch between being practically the same via clearly related but different to being completely unrelated. However, when the forms used in PF and AMB_NR vs. TACT predications are related to each other, these relations are considered to be inflection in some cases, but derivation in others, partly depending on the language-specific tradition and often without any further argumentation. In what follows I will devote some space to the role of predicatives in the Slavic temperature systems and elaborate on how three–layered semantic maps may be useful for capturing cross-linguistic variation in these systems.

The status of Slavic predicatives as inflectional vs. derivational forms and, consequently, their word-class status is disputed, since they are far from both
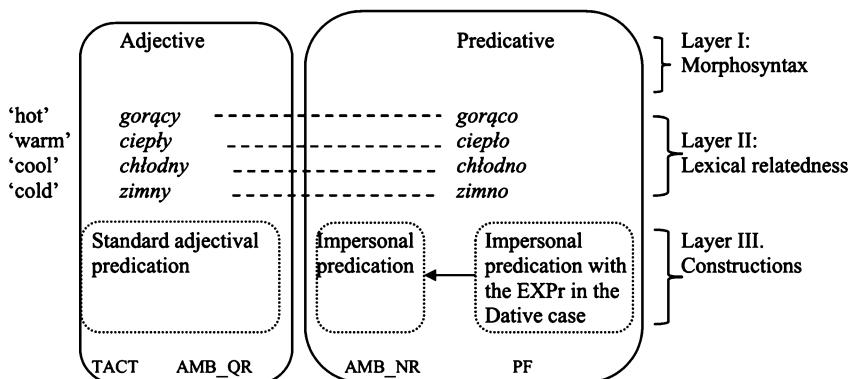
Figure 12: The detailed three-layered semantic map for temperature predications in Polish.

canonical inflection and canonical derivation (cf. Corbett 2010; Spencer 2014: 58–63). In different sources they are therefore classified as either adverbs or as (short) neuter singular forms of adjectives or as a separate word class, partly depending on the language-specific tradition (cf. Letuchij 2017 and Corbett 2004: 207 on Russian and Zimmerling 2018 on Slavic).[12] Importantly, in most cases there is a completely straightforward relation between the temperature adjective and the corresponding predicative, as illustrated by the detailed three-layered semantic map for Polish in Figure 12.

However, the relation between the temperature adjective and the predicative is sometimes less straightforward; the three particularly interesting cases will be considered below (cf. Koptjevskaja-Tamm 2022 on the Slavic temperature systems).

The first case concerns the adjective *horký* 'hot' in Czech, that has two corresponding predicatives – a regular predicative (*horko*) and another one, based on a completely different stem (*vedro*), cf. ex. (15). Since both predicatives show the same ending in *-o* and share the same morphosyntactic behaviour, *vedro* could be considered as the optional suppletive predicative version of *horký* within the regular (inflectional or derivational) paradigm.

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12 Noteworthy, such cases are particularly problematic for François' (2008) distinction between strict and loose colexification (cf. also Georgakopoulos et al. 2016: 422–423 for similar cases).
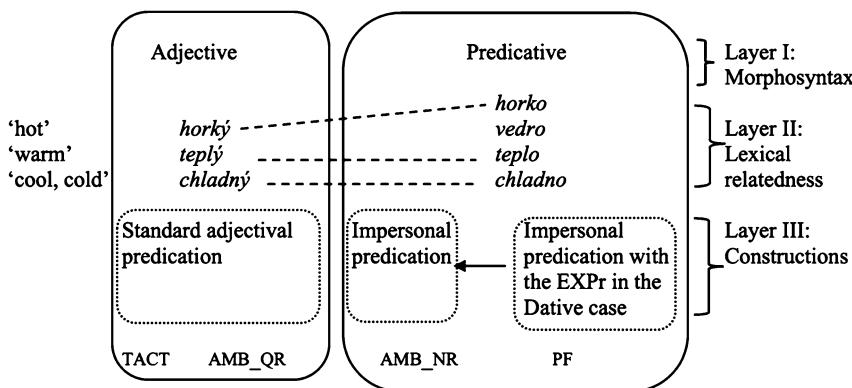
Figure 13: The detailed three-layered semantic map for 'hot', 'warm', and 'cool, cold' temperature predications in Czech (excluding "studený"/"zima" for 'cold').

(15)   Czech (Viktor Elšik p. c.)
   a. TACTILE: *Ten*   *hrnec*   *je* **hork-ý**
             this.M.SG.NOM pot[M].NOM is hot-M.SG.NOM
             'This pot is hot.'
   b. PERSONAL-FEELING: *Byl-o*   *mi*   **hork-o/vedr-o**.
             was-N.SG me.DAT hot-PRED/hot-PRED
             'I felt hot.'
   c. NON-REFERENTIAL AMBIENT: *Včera*   *byl-o*   **hork-o/vedr-o.**
             yesterday was-N.SG hot-PRED/hot-PRED
             'It was hot yesterday.'

Figure 13 represents the temperature system in Czech involving the three of the four central temperature adjectives (*horký* 'hot', *teplý* 'warm' and *chladný* 'cool, cold') and their predicative correspondences. The fourth temperature adjective, *studený* 'cold' will be treated separately immediately below.[13]

   The second case concerns the predicative 'cold' in Czech, Slovak and Upper and Lower Sorbian, *zima*, which is unusual in lacking the ending *-o*. It has the same form as the noun 'winter' and is, strikingly, related to the 'cold' adjective

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13 Both Czech and Slovak have two 'cooling' adjectives – *studený* and *chladný*. The exact semantic difference between those is unclear, but in both languages *chladný* seems to be restricted to some registers and styles (Viktor Elšik for Czech and Pavol Štekauer for Slovak p. c.). Here *chladný* is glossed as 'cool, cold' as opposed to *studený*, glossed as 'cold', since the 'nice cool' nuance is regularly reported for the former, but not for the latter.

in Sorbian (*zymny*), but not to those in Czech or Slovak (*studený*). Moreover, at least in Czech, *zima* can still function both as a noun 'cold' and as a predicative in AMB_NR and PF predications. Ex. (16) shows an intransitive Expertum-oriented PF predication in which *zima* allows adjectival modification and requires gender agreement on the copula. In other words, here it behaves as a proper temperature noun and the whole predication follows the strategy considered in Section 4 (in this case an existential construction expanded by the experiencer in the Dative case). Ex. (16b) is an impersonal construction with the predicative, that (marginally) allows adverbial modification and has a default (neuter) gender form of the copula.

(16)   Czech (Viktor Elšik p. c.): Personal-feeling predications for 'cold'
        a. *Zima* as noun: *Byl**a***   *mi*   (***velká***)   *zima.*
                                 was.3SG.F I.DAT big.NOM.SG.F cold[F].NOM.SG
        b. *Zima* as predicative: *Byl**o***   *mi*   (***moc***)   *zima.*
                                 was.3SG.N I.DAT very   cold.PRED
                                 'I felt (very) cold.'

Viktor Elšik (p. c.) mentions several other colloquial expressions for AMB_NR and PF temperatures involving nouns and the corresponding noun-based predicatives: the somewhat outdated *hic* from German *Hitze* 'heat' (ex. (17a)–(17b)) and several expressions for 'cold' (ex. (17c)–(17d)). According to him, the use of impersonal construction (in which the copula appears in the default form) is more common for the PF predications, conforming to the provisional generalization suggested in Section 4 that the use of a temperature noun in PF predications implies its use in AMB_NR predications.

(17)   Czech (Viktor Elšik p. c.)

        a. *Včera*   ***byl***   *hic*
            yesterday was.M.SG heat[M].NOM.SG
            'It was hot yesterday.'
        b. ***Byl*** / ***Byl-o***   *mi*   *hic*
            was.M.SG / was-N.SG me.DAT heat[M].NOM.SG/PRED
            'I felt hot.'
        c. *Včera*   ***byl-a***   *kosa / kláda / klendra*
            yesterday was-F.SG cold[F].NOM.SG
            'It was cold yesterday.'
        d. ***Byl-a*** / ***byl-o***   *mi*   *kosa / kláda / klendra*
            was-F.SG / was-N.SG me.DAT cold[F].NOM.SG/PRED
            'I felt cold.'

The comparison between the two alternatives in ex. (16) and (17) suggests a tentative historical process by which an erstwhile noun gradually changes its morphosyntactic properties to fit the general construction for a particular function. Evidently, without considering historical data these suggestions remain highly speculative. Figure 14 shows the semantic map for the temperature predications based on *studený/ zima* in Czech and the direction of suggested constructional reanalysis (by thick arrows). In this map the predications with the temperature adjectives are placed above the others to make the representation more reader friendly.
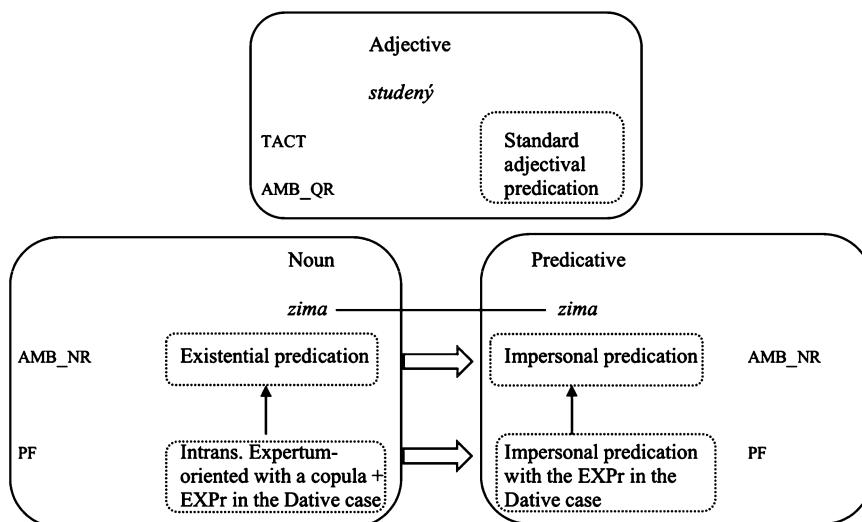
Figure 14: The three-layered semantic map for the 'cold' ("studený" – "zima") temperature predications in Czech (thick arrows show the direction of constructional reanalysis).

In the two Czech cases considered above the distinction between temperature terms based on different lexical stems is intimately related to their morphosyntactic properties: the split occurs therefore between the temperature adjectives used for TACT and AMB_QR predications, and the temperature predicatives/nouns used for AMB_NR and PF predications. The third Slavic case to be considered here is Russian, in which the lexical distinction between the TACTILE (*gorjačij/ gorjačo*) and the NON-TACTILE (*žarkij/ žarko*) 'hot' terms cuts across the morphosyntactic distinction and is therefore more consistent from the semantic point of view (cf. Koptjevskaja-Tamm 2022 on the development of this distinction in Russian). In ex. (18), the adjective *gorjačij* is used exclusively for TACT, while AMB_QR temperatures are described by the adjective *žarkij*, related to the predicative *žarko*,

used for AMB_NR and PF temperatures. Moreover, the TACTILE adjective also has a predicative version, as seen in ex. (18), involving what is called here a "tactile experiencer". What is evaluated here is not the experiencer's "internal state" (as the case is with the PF predications), but something external, the temperature of which can be estimated in a tactile way. This sentence would be appropriate if the water with which Petja is washing his hands is too hot, or when he has touched a very hot surface.

(18)   Russian: *gorjačij/gorjačo* vs. *žarkij/žarko* 'hot' in predication (own data)
      a. TACTILE: *Kastrjul'-a* *byl-a*   **gorjač**-*aja/ej.*
                                   pan-NOM.SG was-F.SG hot_tact-F.SG.NOM/F.SG.INSTR
                                   'The pan was hot.'
      b. QUASI-REF.AMBIENT: *Vesn-a/Pogod-a*   *byl-a*   **žark**-*aja/oj.*
                                   Spring-NOM.SG/weather-NOM.SG was-F.SG hot-F.SG.NOM/INSTR
                                   'The Spring/ weather was hot.'
      c. NON-REF.AMBIENT: *Tam / Včera*   *byl-o*   **žark**-*o.*
                                     there / yesterday was-N.SG hot_nontact-PRED
                                   'It was hot there / yesterday.'
      d. PERSONAL-FEELING: *Mne / Pet-e*   *byl-o*   **žark**-*o.*
                                       I:DAT / Petja-DAT was-N.SG hot_nontact-PRED
                                   'I / Petja felt hot.'
      e. TACTILE EXPERIENCER: *Pet-e*   (*sliškom*) **gorjač-o.**
                                     Petja:DAT (too)   hot_tact-PRED
                                   'It (something) is too hot for Petja to touch'

Figure 15 shows the semantic map for temperature predications in Russian (the tactile experiencer subframe excluded).
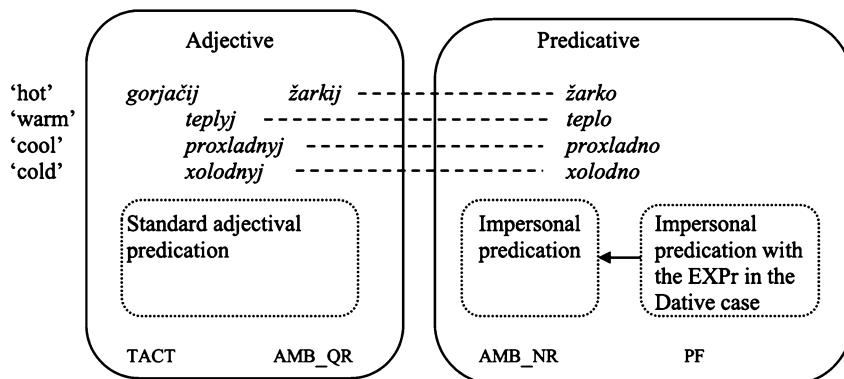

Figure 15: The three-layered semantic map for temperature predications in Russian.

Summarizing the presentation of the temperature systems in Polish, Czech and Russian, we can see how the three-layered semantic maps in Figures 11–14 can assist in visualizing the similarities and the differences among them. The Polish and the Czech temperature systems are basically identical on all the three levels for three of the four temperature values ('hot', 'warm', 'cool/cold'), with the additional suppletive predicative for 'hot' (Figures 12–13). For the 'cold' value in Czech there are two options: one of them (Figure 14b) builds on the predicative for the AMB_NR and PF predications and differs from the Polish system and the rest of the Czech system only on the level of lexical relatedness (the temperature predicative is not related to the temperature adjective). The other option (Figure 14a) has the same configuration as the first one, but differs from it in the details on the morphosyntactic and constructional layers. The Polish and the Russian systems (Figure 12 and Figure 15) are identical on all the three levels for three of the four temperature values ('warm', 'cool', 'cold'), the only difference being the lexical split between the TACTILE and the NON-TACTILE 'hot' for Russian. Crucially, the configurations shown in these maps are not conditional on the decision whether to treat predicatives as being an inflectional form of the corresponding adjectives or as being related to them via derivation.

The consistent lexical distinction between TACTILE and NON-TACTILE uses (covering all AMB and PF uses), is not unique for Russian, but has cross-linguistic correspondences. Among the languages in Table 3 it is made for the 'hot' terms in Komi (*pïm* vs. *žar*, the latter borrowed from Russian) and for both 'hot' (*kavrəm* vs. *ruvəŋ*) and 'cold' (*pɔtəm* vs. *iśk'i*) in another Uralic language, Khanty (khan 1243), cf. ex. (19).

(19)   Khanty: *pɔtəm* vs. *iśk'i* 'cold' in predication (Ladygina 2012 and Nadezhda Grishkina p. c.)

a. TACTILE: *kăt'-əm n'uł-eł*   ***pɔtəm***
                            cat-1SG nose-3SG cold_tact
                            'The cat's nose is cold (to touch)'

b. QUASI-REF.AMBIENT: *ipuš toveł vŏ-s   šeŋk **iśk'i***
                             once Spring be-PST.3SG very cold_nontact
                             'Once the Spring was very cold.'

c. NON-REF.AMBIENT: *nŏmən (śik'em) **iśk'i***
                            above (very)   cold_nontact
                            'It is very cold in the attic.'

d. PERSONAL-FEELING: *man-em(a) **iśk'i***
                            1sg-DAT   cold_nontact
   'I feel cold.'
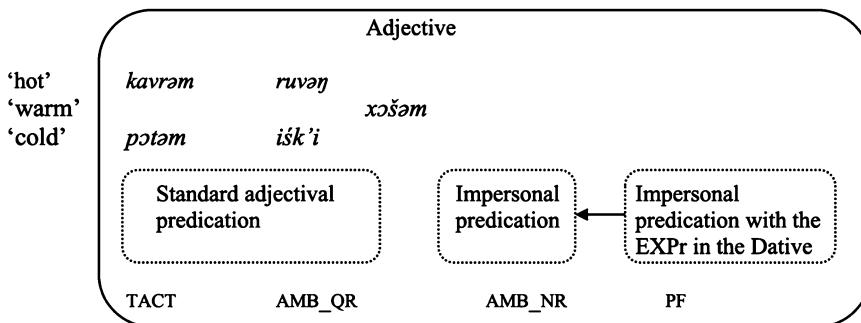
Figure 16: The three-layered semantic map for temperature predications in Khanty.

The final semantic map in this section (Figure 16) shows the temperature system in Khanty. A comparison with the Russian system, shown in Figure 15, shows that the two languages clearly differ on the morphosyntactic level (Khanty lacks morphosyntactic differences between the temperature terms used in the different frames of evaluation), are identical on the constructional level, and share certain similarities on the level of lexical relatedness in having a lexical split between TACTILE and NON-TACTILE temperature terms for some of the temperature values (only for 'hot' in Russian, but for both 'hot' and 'cold' in Khanty).

6 Conclusions

As noted in the beginning of this article, lexical typology has to a large extent been interested in *lexical categorization* of various cognitive domains and in *lexical motivation*, whereas *grammatical behavior* of words and *morphosyntactic patterns* as encoding meanings traditionally belong to grammatical typology. In this study I have attempted to show that the cross-linguistic variation in how languages carve up the domain of temperature cannot be accounted for without considering the interplay between the choice of a particular lexeme and its use in particular constructions. The two leading questions for the study, repeated from Section 1, have been how the lexicon and grammar interact with each other in the expression of the distinctions among the different frames of temperature evaluation across languages, and how this interaction can be represented. I have inspected a number of examples from different languages and have made a case for why the relations among the temperature words involved in predications about TACTILE, QUASI-REFERENTIAL AMBIENT, NON-REFERENTIAL

and PERSONAL-FEELING temperatures need to be analyzed from three different perspectives:

–   their formal relatedness (i. e., whether they are identical, completely unrelated, related via derivation or inflection),
–   their morphosyntactic properties (e. g., their part-of-speech affiliation, inflectional potential, etc.), and
–   the constructions they occur in.

I have argued that these relations can be captured by an elaborated version of classical semantic maps, with three layers corresponding to the three perspectives above. In general, the cases considered in the article confirm the basic configuration of the frames of temperature evaluation, as proposed in my earlier work (Koptjevskaja-Tamm 2011; 2015: 17): TACT – AMB_QR – AMB–NR – PF. I have showcased a number of examples to illustrate some of the ways in which the three layers contribute to the categorization of the domain and demonstrated that the contiguity is maintained on each of them. As argued in Koptjevskaja-Tamm (2015: 17), the motivation for this lies in the conceptual and perceptual affinities of ambient temperature with both TACTILE and PERSONAL-FEELING temperatures. On the one hand, TACTILE and ambient temperatures are experience-based – they are about temperatures that can be verified from "outside". This makes them different from PERSONAL-FEELING temperatures, which are experiencer-based, i. e., are about a subjective "inner" experience of a living being. But on the other hand, AMBIENT and PERSONAL-FEELING temperatures are rooted in the same type of experience, thermal comfort, whereas TACTILE temperature relates to evaluation of the temperature of other entities based on perception received by the skin. And QUASI-REFERENTIAL AMBIENT temperatures are closer to TACTILE temperatures than NON-REFERENTIAL AMBIENT temperatures in pertaining to particular entities.

The enterprise of creating three-layers semantic maps requires a number of analytical decisions that may be coupled with various methodological challenges.

First of all, as in all classical semantic maps, it is necessary to identify the nodes (meanings, functions) relevant for the organization of the semantic domain. All the maps considered in this paper case of temperature are based on four frames of temperature evaluation (TACTILE, QUASI-REFERENTIAL AMBIENT, NON-REFERENTIAL ambient, PERSONAL-FEELING temperatures), whereas most of the earlier research on temperature, including my own (e. g., Lehrer 1970; Prator 1963; Goddard and Wierzbicka 2007; Koptjevskaja-Tamm 2011; FrameNet) basically lumps together the two kinds of ambient temperatures (cf. Section 1). The

decision to distinguish the two was formed in response to the growing cross-linguistic evidence justifying it.

Second, it is not apriori obvious which morphosyntactic categories and properties are relevant for the categorization of the semantic domain. Obviously, exemplary word classes distinctions are easy to spot – a noun and a verb are normally two different words. But in many of the cases considered in the paper the morphosyntactic distinctions are much more subtle, as, for instance, the difference between a fully inflectional adjective and a word that may either be considered as one of its forms or as a word derived from it. In this study I have chosen representations that are sensitive to a broad spectrum of morpho-syntactic distinctions – from the major word-class distinctions of the former type to the fairly fine-grained distinctions of the latter.

Third, the issue of formal relatedness is not always apparent either. On the one extreme, there are challenges with historical relatedness (the extreme case of loose colexification). Do we want to indicate that the two 'hot' adjectives in Russian, *gorjačij* (TACTILE) and *žarkij* (NON-TACTILE) go back to the same Indo-European stem $^{*}g^{u}her$-, but with different vowels? Probably not. But considering more transparent cases, does it matter – and for whom and for what – that the 'cold' adjective (*šidáalu*) and the 'cold' noun (*šid*) in Palula are historically related, as contrasted to the 'hot' adjective (*táatu/téeti*) and the 'hot' noun (*húluk*)? On the other extreme, the distinction between strict and loose colexification, or the one between one and the same lexeme and different lexemes, is also often tricky.[14] Are the different manifestations of Italian *freddo* 'cold' discussed in Section 4 and shown in Figure 7 one and the same lexeme with both adjectival and nouny properties, or are there two different lexemes related by conversion? Are the Slavic predicatives and the corresponding adjectives one and the same lexeme or are they related by derivation?

Finally, identifying constructions and their relations is, again, a delicate issue. To come back to the first examples considered in this paper: how should the constructions used for AMB_NR predications in English (ex. (1c)) and Wolof (ex. (2c)) be analyzed? They are basically the same as those used for all the other temperature predications, except for the invariant ambient/dummy subject, which probably justifies their treatment as connected to the others via an inheritance link of the 'instance' type. I leave the details of graphic implementation of these relations on a semantic map without violating the connectivity requirement for the future.

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14 See the point discussed above in connection with morphosyntactic categories and already mentioned in fn. 12.

Now, it is unsurprising that semantic maps of the kind suggested here are beneficial for capturing the temperature system of a particular language, but what about cross-linguistic comparison? It is true that fully elaborated three-layered semantic maps like those in Figure 8 and Figures 12–16 are simply too detailed and may be – and most probably often are – unmanageable in cross-linguistic comparison. This is also a problem inherent in most constructional approaches to language description and analysis, which often result in meticulous language-specific networks, hardly generalizable to other languages. However, as illustrated throughout Section 5, cross-linguistic comparison can advantageously be done on the basis of more schematic representations, like those in Figures 9–11, which focus on particular configurations on particular levels (e. g., particular morphosyntactic or constructional configurations) and leave out the more specific details. The option of using more detailed or more schematic representations for specific purposes is of course not completely novel, but is very much in the spirit of what typologists always do, given the general tension between the richness of their language-specific data and the leading concern to reduce them to manageable patterns. A parallel near at hand within the area of semantic maps and constructions is found in Traugott's (2016) study of modals, where she suggests to combine schema-construction maps to represent relationships between abstract, conceptual schemas linked to form, with micro-construction maps to represent relationships between specific constructions in the expression of.

On a closing note: I hope to have shown the advantages of applying three-layered semantic maps to study how different means jointly carve up the temperature domain, the task in which the lexical, morphosyntactic and constructional distinctions are often inseparable from each other. It is reasonable to ask if the issue of joint linguistic expression of categories is particularly relevant for the temperature domain (and also for the super-domain of LOCATION–EXISTENCE–POSSESSION considered in Koch (2012) (cf. Section 3), to the exclusion of others. In other words, whether the practical application of three-layered semantic maps is basically restricted to one single domain. At the present I lack any clear answer to this question – after all, most of the lexical-typological research has been successfully done on the level of lexemes, without messing up with their grammatical or constructional behaviour. On the other hand, there is also research which aspires to reconcile the lexical and grammatical interests. For instance, one of the leading issues in the project on categorization of the CUT and BREAK domain (Majid and Bowerman 2007) has been the interface between syntax and lexical semantics, i. e., to what extent and how the argument structure properties of a verb are predictable from its meaning. For the AQUA-MOTION domain, Koptjevskaja-Tamm et al. (2010) argue that the different lexicalizations

in the Swedish-Dutch-German systems correspond to the constructional differ-ences in the lexically much much less elaborated Polish-Russian systems (cf. Rakhilina et al. 2022 for the basic information on the aqua-motion domain). It is my contention that research in both grammatical and lexical typology will benefit greatly from a more careful examination of lexicon-grammar interaction across languages, and that multiple-layered semantic maps may be a suitable tool in this endeavour (cf. Koptjevskaja-Tamm and Veselinova 2020 for research questions common to lexical typology and morphology).

Table 2: Languages in which PF predications involve temperature nouns.

Language	concept	TACT /AMB_QR Standard predication: V(erbal), A(djectival), O(ther)	AMB_NR	Exst (Existential predication), Amb (other Ambient)	PF	EXPr or EXPm oriented predication: Intr(ansitive), Tr(ansitive)	Formal relations between words	Relations between constructions for AMB_NR and PF
Bamana (Mande)	'hot'	O / kálan or gòni (QSV)	fùnténi (N)	Exst	fùnténi (N)	EXPm Intr + EXPr with the locative / possessive marker	unrelated	Inheritance (subpart): EXPm Intr = Exst + EXPr with the locative / possessive marker
	'cold'	súma (QSV)	nɛ́nɛ (N)		nɛ́nɛ (N)			
Ewe (Kwa)	'hot'	V / xɔ dzɔ / dze dzɔ 'catch / contact fire' (verbal expression)	afɩ́fɩ́á 'sweat' (N)	Exst; Amb with 'do/happen'	afɩ́fɩ́á 'sweat' (N)	EXPr Tr with 'see'; EXPm Tr with 'do/happen'	unrelated	Inheritance (subpart): EXPm Tr with 'do/happen' = AMB_NR+ EXPr as object
	'cold'	fá (V)	avʊvɔ (N)		avʊvɔ (N)			
Likpe (Sɛkpɛlɛ̃) (Kwa)	'hot'	V / yila 'be(come) hot' (V)	lí-wi 'CM-sweat' (N)	Exst	lí-wi 'CM-sweat' (N)	EXPm Tr with 'hold'	unrelated	unrelated
	'cold'	yúa 'become cold'	lɛ-yɔ 'cold' (N)		lɛ-yɔ 'cold' (N)			

Table 2 (continued)

Language	concept	TACT /AMB_QR	Standard predication: V(erbal), A(djectival), O(ther)	AMB_NR	Exst (Existential predication), Amb (other Ambient)	PF	EXPr or EXPm oriented predication: Intr(ansitive)/Tr(ansitive)	Formal relations between words	Relations between constructions for AMB_NR and PF
Palula (Indo-Aryan)	'hot'	*táatu/téeti* (A)	A	*húluk* (N)	Exst	*húluk* (N)	EXPm Intr with motion verbs + EXPr with the locative / goal marker	unrelated	unrelated
	'cold'	*šidáalu* (A)		*šid* (N)		*šid* (N)		related, but not productively	
Hindi (Indic)	'hot'	*garam* (A)	A	*garmii* (N)	Exst	*garmii* (N)	EXPm Intr with 'stick to' + EXPr in the Dative case	related	unrelated
	'cold'	*thaṇḍaa* (A)		*thaṇḍ* (N)		*thaṇḍ* (N)			
Maltese (Arabic)	'hot'	*sħun* (A)	A	*(is-)sħana* (N)	Exst	*(is-)sħana* (N)	EXPr Tr with 'feel'	productively related	unrelated
	'cold'	*kiesaħ* (A)		*(il-)ksieħ* (N)		*(il-)ksieħ* (N)			
Algerian Arabic (Arabic)*	'hot'	*sxun* (A)	A	*sxana* (N)	Amb	*sxana* (N)	EXPr Intr with 'feel'	productively related	unrelated
	'warm'	*dafi* (A)		*dfa* (N)		*dfa* (N)			
	'cold'	*barad* (A)		*bard* (N)		*bard* (N)			

Table 2 (continued)

Language	concept	TACT /AMB_QR	Standard predication: V(erbal), A(djectival), O(ther)	AMB_NR	Exst (Existential predication), Amb (other Ambient)	PF	EXPr or EXPm oriented predication: Intr(ansitive), Tr(ansitive)	Formal relations between words	Relations between constructions for AMB_NR and PF
Spanish (Romance)	'hot'	caliente (A)	A	calor (N)	Amb	calor (N)	EXPr Tr with 'have'	related the same word? conversion?	unrelated
	'cold'	frío (A/N)		frío (A/N)		frío (A/N)			
Italian (Romance)	'hot'	caldo (A/N)	A	caldo (A/N)	Amb	caldo (A/N)	EXPr Tr with 'have'	the same word? conversion?	unrelated
	'cold'	freddo (A/N)		freddo (A/N)		freddo (A/N)			
Romanian (Romance)**	'cold'	rece (A)	A	frig (N)	Exst	frig (N)	EXPm Intr + EXPr in the Dative case	unrelated	Inheritance (subpart): EXPm Intr = Exst + EXPr in the Dative case

Notes: *Algerian Arabic has additional constructions for PF temperatures, not considered here. **Romanian uses constructions with the noun *frig* as the alternative for the adjective based AMB-NR and PF predications for 'cold' (cf. Table 3 for the other more regular alternatives).

Table 3: Languages in which PF predications follow the Non-oriented intransitive strategy.

Language	concept	TACT /AMB_QR Standard A(djectival predication)	AMB_NR	Predication: Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
German (Germanic)	'hot'	heiss (A, default)	heiss (A, default)	AmbS	heiss (A, default)	D	the same word form	unrelated
	'warm'	warm (A, default)	warm (A, default)		warm (A, default)			
	'cold'	kalt (A, default)	kalt (A, default)		kalt (A, default)			
Icelandic (Germanic)	'hot'	heittur (A, agreement)	heitt (A, neuter)	AmbS	heitt (A, neuter)	D	the same lexeme, different inflectional potential	unrelated
	'cold'	kaltur (A, agreement)	kalt (A, neuter)		kalt (A, neuter)			
*Romanian** (Romance)	'hot'	cald (A, agreement)	cald (A, default)	Impers	cald (A, default)	D	the same lexeme, different inflectional potential	subpart link
	'cold'	rece (A, agreement)	rece (A, default) [frig (N)]		rece (A, default) / [frig (N)]			

Standard A(djectival predication) column: A (for each language row).

Table 3 (continued)

Language	concept	TACT /AMB_QR Standard A(djectival predication)		AMB_NR	Predication: Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Lithuanian (Baltic)	'hot'	*karštas* (A, agreement)	A	*karšta* (A, N.SG.NOM)	Impers	*karšta* (A, N.SG.NOM)	D	the same lexeme, different inflectional potential	subpart link
	'warm'	*šiltas* (A, agreement)		*šilta* (A, N.SG.NOM)		*šilta* (A, N.SG.NOM)			
	'cold'	*šaltas* (A, agreement)		*šalta* (A, N.SG.NOM)		*šalta* (A, N.SG.NOM)			
Latvian (Baltic)	'hot'	*karsts* (A, agreement)	A	*karsts* (A, M.SG.NOM) / *karsti* (Adv)	Impers	*karsti* (Adv)	D	the same lexeme with subpart link, different inflectional potential or related lexemes	the same lexeme with subpart link
	'warm'	*silts* (A, agreement)		*silts* (A, M.SG.NOM) / *silti* (Adv)		*silti* (Adv)			
	'cold'	*auksts* (A, agreement)		*auksts* (A, M.SG.NOM) / *auksti* (Adv)		*auksti* (Adv)			

Table 3 (continued)

Language	concept	TACT /AMB_QR Standard A(djectival predication)	AMB_NR	Predication: Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Polish (Slavic)	'hot'	*gorący* (A, agreement)	*gorąco* (PRED)	Impers	*gorąco* (PRED)	D	the same lexeme with different inflectional potential or related lexemes	the same lexeme with subpart link
	'warm'	*ciepły* (A, agreement)	*ciepło* (PRED)		*ciepło* (PRED)			
	'cold'	*chłodny* (A, agreement)	*chłodno* (PRED)		*chłodno* (PRED)			
	'cold'	*zimny* (A, agreement)	*zimno* (PRED)		*zimno* (PRED)			
*Czech*** (Slavic)	'hot'	*horký* (A, agreement)	*vedro* (PRED) *horko* (PRED)	Impers	*vedro* (PRED) *horko* (PRED)	D	unrelated lexemes	subpart link
	'warm'	*teplý* (A, agreement)	*teplo* (PRED)		*teplo* (PRED)		the same lexeme with different inflectional potential or related lexemes	
	'cold, cool' *chladný*	*chladný* (A, agreement)	*chladno* (PRED)		*chladno* (PRED)			
	'cold'	*studený* (A, agreement)	*zima* (N/PRED)	Other / Impers	*zima* (N/PRED)	Other / D	unrelated lexemes	

Table 3 (continued)

Language	concept	TACT /AMB_QR Standard A(djectival predication)	AMB_NR	Predication: Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Russian (Slavic)	'hot'	TACT: *gorjačij* (A, agreement) AMB_QR: *žarkij* (A, agreement)	*žarko* (PRED)	Impers	*žarko* (PRED)	D	TACT and AMB + PF unrelated; AMB_QR and AMB_NR + PF words: the same lexeme with different inflectional potential or related lexemes	subpart link
	'warm'	*teplyj* (A, agreement)	*teplo* (PRED)		*teplo* (PRED)		the same lexeme with different inflectional potential or related lexemes	
	'cool'	*proxladnyj* (A, agreement)	*proxladno* (PRED)		*proxladno* (PRED)			
	'cold'	*xolodnyj* (A, agreement)	*xolodno* (PRED)		*xolodno* (PRED)			

Table 3 (continued)

Language	concept	TACT /AMB_QR	Standard A(djectival) predication)	AMB_NR	Predication: Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Finnish (Uralic)	'hot'	*kuuma* (A, Nom, agreement)	A	*kuuma* (A, Nom, no agr) / *kuumaa* (A, Part, no agr)	*kuuma* (A, Nom, Impers)	*kuuma* (A, Nom, no agreement)	Ad	the same lexeme with subpart link, different inflectional potential	
	'warm'	*lämmin* (A, Nom, agreement)		*lämmin* (A, Nom, no agr) / *lämmintä* (A, Part, no agr)		*lämmin* (A, Nom, no agreement)			
	'cold'	*kylmä* (A, Nom, agreement)		*kylmä* (A, Nom, no agr) / *kylmää* (A, Part, no agr)		*kylmä* (A, Nom, no agreement)			
Mordvin-Moksha (Uralic)	'hot'	*psi* (A, no agreement)	A	*psi* (A, no agreement)	Impers	*psi* (A, no agreement)	Dat	the same word form	subpart link
	'warm'	*ljambe* (A, no agreement)		*ljambe* (A, no agr)		*ljambe* (A, no agr)			
	'cold'	*kel'me* (A, no agreement)		*kel'me* (A, no agr)		*kel'me* (A, no agr)			

Table 3 (continued)

Language	concept TACT/AMB_QR	Standard A(djectival predication)	AMB_NR	Predication: PF Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Khanty (Uralic)	'hot'	TACT: *kavəm* (A, no agr) AMB_QR: *ruvəŋ* (A, no agreement)	*ruvəŋ* (A, no agreement)	Impers	*ruvəŋ* (A, no agreement)	Dat	TACT and AMB + PF unrelated; AMB_QR and AMB_NR + PF – the same word form	subpart link
	'warm'	*xɔšəm* (A, no agreement)	*m'elak* [outside] / *xɔšəm* [inside] (A, no agr)		*xɔšəm* (A, no agreement)		the same word form	
	'cold'	TACT: *pɔtəm* (A, no agr) AMB_QR: *iśk'i* (A, no agreement)	*iśk'i* (A, no agreement)		*iśk'i* (A, no agreement)		TACT and AMB + PF unrelated; AMB_QR and AMB_NR + PF – the same word form	

Table 3 (continued)

Language	concept	TACT /AMB_QR Standard A(djectival predication)	AMB_NR	Predication: Impers(onal), Amb(ient) S(ubject), Other	PF	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Komi-Permyak (Uralic)	'hot'	TACT: *pim* (A, no agr) (*dziryt*) AMB_QR: *žar* (A, no agr)	*žar* (A, no agreement)	Impers	*žar* (A, no agreement)	Dat	TACT and AMB + PF unrelated; AMB_QR and AMB_NR + PF – the same word form	subpart link
	'warm'	*šonit* (A, no agreement)	*šonit* (A, no agreement)		*šonit* (A, no agr)		the same word form	
	'cold'	*ködzyt* (A, no agreement)	*ködzyt* (A, no agreement)		*ködzyt* (A, no agr)			
Komi-Zyrian (Uralic)	'hot'	TACT: *pim* (A, no agr) (*pës'*) AMB_QR: *žar* (A, no agr)	*žar* (A, no agreement)	Impers	*žar* (A, no agreement)	Dat	TACT and AMB + PF unrelated; AMB_QR and AMB_NR + PF – the same word form	subpart link
	'warm'	*šonïd* (A, no agreement)	*šonïd* (A, no agreement)		*šonïd* (A, no agr)		the same word form	
	'cold'	*ködzyd* (A, no agreement)	*ködzyd* (A, no agreement)		*ködzyd* (A, no agr)			

Table 3 (continued)

Language	concept	TACT /AMB_QR Standard A(djectival predication)	AMB_NR	Predication: PF Impers(onal), Amb(ient) S(ubject), Other	Impersonal predication with the EXPr in the D(ative) or Ad(essive) case; Other	Formal relations between TACT /AMB_QR and PF words	Relations between AMB_NR and PF constructions: unrelated or related via subpart link
Bashkir (Turkic)	'hot'	eθe (A, no agreement)	A	eθe (A, no agreement)	Impers	Dat	the same word form	subpart link
	'cold'	hawaq (A, no agreement)	hawaq (A, no agreement)	hawaq (A, no agr)				

Notes: *Romanian uses constructions with the noun *frig* as the alternative for the adjective based AMB-NR and PF predications for 'cold' (cf. Table 2). **zima 'cold' in AMB-NR and PF predications in Czech can function both as a noun and as a predicative (cf. ex. (16) and Figure 11 in Section 5).

Table 4: Languages and sources.

Language	Affiliation	Location	Glottolog-codes	Sources
Algerian Arabic	Arabic, Semitic, Afro-Asiatic	Algeria	alge1239	Lameen Souag (p. c.)
Armenian, Modern Eastern	Armenic, Indo-European	Armenia	nucl1235	Daniel and Khurshudian (2015)
Bamana (Bambara)	Mande, Niger-Congo	Mali	bamb1269	Valentin Vydrin p. c., Vydrin (2017), Dumestre (2011), Bailleul et al. (2011–2020)
Bashkir	Kipchak, Turkic	Russia	bash1264	Denis Kirjanov p. c.
Czech	Slavic, Indo-European	Czech Republic	czec1258	Viktor Elšík p. c.,, Koptjevskaja-Tamm (2022)
Ewe	Kwa, Niger-Congo	Ghana, Togo	ewee1241	Ameka (2015)
Finnish	Finnic, Uralic	Finland	finn1318	Juvonen and Nikunlassi (2015)
German	Germanic, Indo-European	Germany, Switzerland, Austria	stan1295	Pustet (2015)
Hindi	Indo-Iranian, Indo-European	India	hind1269	Peter Hook p. c.
Icelandic	Germanic, Indo-European	Iceland	icel1247	Elísabet Eir Cortes p. c., Pétur Helgason p. c.
Italian	Romance, Indo-European	Italy	ital1288	Luraghi (2015)
Japanese	Japonic	Japan	nucl1643	Shindo (2015)
Kamang	Timor-Alor-Pantar	Indonesia	kama1365	Schapper (2015)
Khanty	Khantyic, Uralic	Russia (Siberia)	khan1273	Ladygina (2012)
Komi-Permyak	Permian, Uralic	Russia (NE European part)	komi1269	Ladygina (2012)
Komi-Zyrian	Permian, Uralic	Russia (NE European part)	komi1268	Nikolaj Kuznecov p. c., Timusev and Kolegova (1961)
Latvian	Baltic, Indo-European	Latvia	latv1249	Perkova (2015)
Likpe (Sɛkpɛlé)	Kwa, Niger-Congo	Ghana,	sekp1241	Ameka (2015)

Table 4 (continued)

Language	Affiliation	Location	Glottolog-codes	Sources
Lithuanian	Baltic, Indo-European	Lithuania	lith1252	Perkova (2015)
Maltese	Arabic, Semitic, Afro-Asiatic	Malta	malt254	Michael Spagnol, Antoinette Camiglieri, Martine Vanhove p. c., Aquilina (1987; 1990)
Mordvin-Moksha	Mordvin, Uralic	Russia	moks1248	Tatiana p. c.
Palula	Indo-Aryan, Indo-European	Pakistan	phal1254	Liljegren and Haider (2015)
Polish	Slavic, Indo-European	Poland	poli1260	Marcin Włodarczak p. c., Koptjevskaja-Tamm (2022)
Romanian	Romance, Indo-European	Romania, Moldova	roma1327	Gabriela Alboiu p. c., Dan Dediu p. c.
Russian	Slavic, Indo-European	Russia	russ1263	own data, Koptjevskaja-Tamm (2022)
Spanish	Romance, Indo-European	Spain, many countries in South America	stan1288	Pustet (2015)
Wolof	Atlantic, Niger-Congo	Senegal	nuc1347	Jean Léopold Diouf p. c., Perrin (2015), Robert (2010), Creissels et al. (2015)

Abbreviations

A	adjective
ACC	accusative
ADV	adverb
AMB	ambient temperature
CM	class marker
DAT	dative
DEF	definite
DO	direct object
F	feminine
INSTR	instrumental
IPFV	imperfective
LOC	locative
M	masculine
N	noun; neutral
NOM	nominative
NR	non-referential
PF	personal-feeling temperature
PL	plural
POSS	possessive
POSTP	postposition
PRED	predicative
PRES	present
PROG	progressive
PST	past
QR	quasi-referential
QSV	quality state verb
RED	reduplication
SG	singular
TACT	tactile temperature
V	verb
VF	verbal focus

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