Temporal adverbial clauses: A cross-linguistic perspective

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The study explores the form and function of 'when', 'while', 'after', 'before', and 'until' clauses in a variety sample of 218 languages. First, it is demonstrated that temporal adverbial clauses tend to be encoded with conjunctions and converbs in the database. A chi-squared goodness-of-fit test shows that 'after', 'before', and 'until' meanings are strongly and similarly associated with monofunctional clause-linking devices cross-linguistically. 'While' meanings are ambivalent, and 'when' meanings are strongly encoded with polyfunctional clause-linking devices. Second, the paper also explores the polyfunctionality patterns of temporal adverbial clause-linking devices. While the semantic polyfunctionality patterns attested in the present research align, for the most part, with those documented by other typological studies, there are a number of patterns that have been neglected in the typological literature, such as the polyfunctionality pattern between 'while' and 'without', between 'after' and 'lest', and between 'before' and 'lest', among others.

Keywords: temporal clauses, adverbial clauses, subordination, clause combining, complex sentence

1. Introduction

In temporal adverbial clause constructions, one clause can locate the situation expressed in another clause in time (Thompson et al. 2007: 243). Given the large spectrum of possible situations (*p* before/after/until *q*, etc.), temporal adverbial clauses represent the most semantically diverse class of adverbial clauses (Luk 2023: 43) as well as the most challenging class for interpretation (Lin 2015: 162). 'When' clauses are not specific in that the exact extent of the temporal meaning is unspecified and subject to variation (Cristofaro 2012; Diessel 2008: 470; Guerrero 2021; Hetterle 2015: 47). They can convey any reference time (i.e., before, after, and around the time of the main clause) and can also convey any time interval (e.g., short or long). However, the reference time and the time interval can only be recovered from the discourse context (Cristofaro 2003: 159). 'While' clauses express situations of co--occurrence or concomitance, i.e., situations taking place at the same time as the situation

expressed in the main clause (Dixon 2009: 10; Hetterle 2015: 47). Relations of temporal anteriority ('after' relations) involve two situations occurring in a sequence. In this case, the dependent situation is anterior to the main one (Cristofaro 2003: 159). In 'before' constructions, the dependent situation follows the main one in time and is selected as a temporal reference point for it (Cristofaro 2003: 159). Temporal clauses expressing terminal boundary ('until' clauses) mark the endpoint of a situation expressed in the main clause (Kortmann 1997: 85; Hetterle 2015: 48).

There are a number of typological studies that have explored specific types of temporal adverbial clauses, such as 'when' clauses (Cristofaro 2012; Guerrero 2021), 'while' clauses (Olguín Martínez 2020), 'after' clauses (Martowicz 2011: 108), 'before' clauses (Hetterle 2015: 221), and 'until' clauses (Hetterle 2015: 48). Still missing, however, is an attempt at exploring the expression of temporal adverbial relations in a single study. This type of analysis can lead us to make generalizations across them and can be invaluable to those documenting and describing languages, alerting them to details to watch for and chronicle.

The present study explores (1) 'when', (2) 'while', (3) 'after', (4) 'before', and (5) 'until' clauses in a variety sample of 218 languages.[1] In particular, special attention is paid to the following issue. Clause-linking devices encoding temporal adverbial clauses may be semantically monofunctional, i.e., they are only used for expressing one adverbal relation or semantically polyfunctional, i.e., they are used for expressing different adverbial relations in specific contexts (e.g., 'if', 'because', 'although'). The question is: cross-linguistically, which types of temporal adverbial clauses tend to be encoded by semantic monofunctional clause-linking devices disproportionately more often than semantic polyfunctional clause-linking devices?

In the second part of the paper, a more in-depth analysis of the semantic polyfunctionality of clause-linking devices is provided. Most studies that have addressed this domain have only taken into account a particular type of device (e.g., Kortmann 1997 only takes into account conjunctions) or two types of devices (e.g., Hetterle 2015 only takes into account conjunctions and converbs). Accordingly, it is not clear whether other clause-linking devices that have been traditionally disregarded ('and then' coordinators) will show polyfunctionality patterns not attested in previous studies. The question is: do the semantic polyfunctionality patterns attested in the present study align with those documented by other typological studies?

This paper is organized as follows: §2 presents the method for compiling the sample of the present research, briefly discussing the limits and advantages of such large-scale database. §3 introduces the range of clause-linkage patterns by which 'when', 'while', 'after', 'before', and 'until' clauses are formed in the sample. In §4, we apply a chi-squared goodness-of-fit test to explore the degree to which a temporal adverbial clause type is skewed towards semantic monofunctionality or polyfunctionality (and to determine the reliability of this skew). Moreover, this section investigates the range of polyfunctionality patterns attested in the sample. §5 summarizes the main findings of the present research.

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[1] Other types of temporal adverbial clauses, such as 'as long as' and temporal 'since' clauses, do not play a role in the present study due to the scarcity of data in the sample.

2. Sample

In the present study, we take into account a sample of 218 languages based on the Genus-
-Macroarea method proposed by Miestamo (2005). In particular, the bottom-up variant of
the method has been adopted here. In this variant, sample size is not predetermined. Instead,
this variant tries to include languages from as many genera as possible, and the language
chosen from each genus is made based on the availability of the sources (Miestamo et al.
2016: 247). Based on this, an attempted was made to find one language from each of Dryer's
genera for which the available literature gives sufficient information on the grammar of tem-
poral clause-linking strategies encoding: (1) 'when', (2) 'while', (3) 'after', (4) 'before', and
(5) 'until' clauses. Of the 543 genera proposed by Dryer, it was possible to find sufficient
information on 218 genera, which accounts for the final sample of 218 languages. In this
method, the primary genetic stratification is made at the genus level, and the primary areal
stratification at the level of macro-areas. The languages in the sample are shown in Table 1.
Using this type of sample maximizes the likelihood of finding the different types that occur
cross-linguistically.

Table 1: Languages in the sample per macro-area

Macro-area	Sample languages	Sum
Africa	!Xun, Bangime, Beja, Boko, Duka, Emai, Eton, Fongbe, Gaahmg, Gumuz, Hadza, Hausa, Hebrew, Ik, Iraqw, Izi, Jalkunan, Kabba, Kisi, Koyra Chiini, Lango, Lele, Lumun, Ma'di, Majang, Makary Kotoko, Mbembe, Mbodomo, N/uuki, Ngiti, Noon, Nubian, Sidaama, Somali, Supyire, Tamashek, Ts'ixa, Tommo So	38
Australia	Anindilyakwa, Arrernte, Bardi, Bininj Gun-Wok, Gaagudju, Gamilaraay, Garrwa, Gooniyandi, Gurr-Goni, Kalkatungu, Kayardild, Mangarrayi, Marrithiyel, Meryam Mir, Miriwung, Nakkara, Ngankikurungkurr, Nyangumartha, Wagiman, Wambaya, Worrorra	21
Eurasia	Abkhaz, Ainu, Armenian, Atong, Bantawa, Baoan, Basque, Bru, Bunan, Burushaski, Dargwa, Dhimal, English, Finnish, Galo, Georgian, Greek, Hungarian, Ingush, Japanese, Japhug, Kayah Monu, Kasong, Ket, Kharia, Khmer, Khwarshi, Korean, Lao, Lawa, Lezgian, Lithuanian, Malto, Man-darin, Mongsen Ao, Nuosu, Palula, Persian, Pnar, Russian, Saami, Seme-lai, Spanish, Tamil, Tangsa, Telugu, Tundra Nenets, Turkish, Udihe, Udmurt, Welsh, Xong, Yukaghir, Zoulei	54
North Ame-rica	Alacatlatzala Mixtec, Amuzgo, Ayutla Mixe, Barbareño Chumash, Cherokee, Central Alaskan Yup'ik, Chitimacha, Chontal, Cora, Creek, Crow, Cupeño, Haida, Huasteca Nahuatl, Isthmus Zapotec, Lillooet, Maricopa, Musqueam, Ottawa, Onondaga, Rama, Sahaptin, Santiago Chinantec, Slave, Southeastern Tepehuan, Teribe, Necaxa Totonac, Tzeltal, Ute, Warihio, Yaqui, Yuchi	32

Papunesia	Abau, Abui, Aghu, Amele, Awtuw, Balantak, Barupu, Batak, Begak, Bilua, Hatam, Ilocano, Inanwatan, Indonesian, Kaluli, Komnzo, Makasae, Manambu, Marind, Maybrat, Momu, Moskona, Motuna, Namia, Oksapmin, Paiwan, Puyuma, Rukai, Saaroa, Savosavo, Tagalog, Tetun, Thao, Tidore, Tina Sambal, Toqabaqita, Urim, West Coast Bajau, Wooi, Yimas	40
South America	Aguaruna, Alto Perené, Apinajé, Baure, Cavineña, Cholón, Cubeo, Epena Pedee, Garifuna, Huitoto, Hup, Iquito, Kakua, Kokama Kokamilla, Kwaza, Macushi, Mako, Mamaindé, Mapuche, Matsés, Mosetén, Movima, Paez, Paresi, Paumarí, Piro, Sanuma, Tariana, Trumai, Urarina, Yagua, Yauyos Quechua, Yurakaré	33

Table 2: Number of genera included in the sample

Macro-area	Number of genera	Number of genera in the sample	Coverage
Africa	77	38	49.35%
Australia	43	21	48.83%
Eurasia	82	54	65.85%
North America	95	32	33.68%
Papunesia	136	40	29.41%
South America	110	33	30%
Total	543	218	40.14%

Areal stratification plays an important role in that it ensures that the number of languages in a sample are uniformly distributed over geographically independent areas. Dryer (1992) distinguishes the following macro-areas: Africa, Eurasia, Southeast Asia and Oceania, Australia and New Guinea, North America, and South America. Based on geographical independence, Hammarström & Donohue (2014) review these macro-areas and propose a different division: Africa, Eurasia, Papunesia, Australia, North America, and South America. These areas have been adopted in the latest editions of WALS instead of Dryer's original six areas (Miestamo et al. 2016: 240). While an ideal language sample would also be areally balanced, it is difficult to come up with a sample that is both genetically and areally balanced, for the simple reason that some macro-areas have more genera than others. Furthermore, some macro-areas are better represented than others because of the availability and quality of the sources. As is shown in Table 2, Eurasia is somewhat overrepresented in comparison to the other macro-areas, i.e., Australia, North America, and South America.

Overall, the sample of the present study aims at broad genetic and geographical coverage of the world's languages. Its basic classificatory principle is that of genetic independence, but as was shown above, two or more languages from different genera of the

same family may be taken into account. The sample is thus quite well-suited to exploring cross-linguistic variation in the encoding of temporal adverbial clauses.

3. Temporal adverbial clauses: Clause-linking devices

Temporal adverbial clauses are encoded with different clause-linking devices in the languages in the sample. Many languages use CONJUNCTIONS for expressing temporal adverbial relations, as in (1). These are morphemes that may appear in different positions at the clause over which they operate (i.e., they may appear at the beginning of the dependent clause) (Kortmann 1997: 72). Clauses in constructions encoded with conjunctions may be presented in a different order without changing the meaning expressed by the complex sentence construction (Mauri 2008: 84).

Bangime (Isolate)

(1)   *ŋ̀*   *déŋgò*   **hà**   *Séédù*   *à*   ∅   *twáá*   *gāndà*.

       1SG.SBJ   wait.PFV   until   *Séédù*   COMPL   3SG.SBJ   arrive.PFV   place

       'I waited until Seydou arrived.' (Heath & Hantgan 2018: 498)

Languages may also resort to CONVERBS. A converb is a special verb form that does not appear in independent declarative clauses (Haspelmath 1995: 3). The clause containing the converb encodes a restrictive (modifying) or non-restrictive (non-modifying) proposition with respect to its main clause predicate (2). The order of the clauses in constructions encoded by converbs may be presented in a different order without changing the meaning expressed by the complex sentence construction. Converbs are part of the inflectional paradigm of verbs and thus in paradigmatic contrast to other inflectional morphemes (Haspelmath 1995: 4).

Kusunda (Isolate)

(2)   *am-**de***   *u-g-i*.

       eat-CVB   come-3SG.SBJ-PST

       'He came before eating.' (Watters 2006: 128)

'AND THEN' COORDINATORS are morphemes that are specifically used for encoding the temporally subsequent construction (Dixon 2009: 9), as can be seen in the Gooniyandi example in (3). Clauses linked with 'and then' coordinating devices always follow an iconic order. Accordingly, languages having 'and then' coordinating devices do not allow the order of clauses to be changed. Note that 'and then' devices tend to introduce clauses that appear with the same properties as independent declarative clauses. These devices may become discourse markers in many languages (Brody 2011: 10), that is, morphemes that link clauses inter--sententially and which are important in discourse structuring and narrative sequencing.

Gooniyandi (Bunuban)

(3) *yoowooloo*   *garndiwangooddoo-ngga*   *gardboowooddarni*,
     men   many-ERG   they.fought.together
     'Many men fought together,

     niyi-nhingi   *nardawooddarni*   *thiddi-nhingi-ngga*.
     that-ABL (and then)   they.cried.together   fight-ABL-ERG
     and then they cried together afterwards.' (McGregor 1990: 428)

One important methodological challenge should be mentioned here. Some sources of the sample provide descriptions of clause-linking devices glossed as 'and'. At first glance, these devices look like general coordinating devices. However, a closer analysis reveals that they are 'and then' coordinating devices in that they are used exclusively for expressing temporal subsequence. A case in point is found in Daga. This language has a clause-linking device with the form *si* glossed as 'and' in all the examples provided in the source consulted (4). However, Murane (1974: 170) mentions that this clause-linking device only signals temporal subsequence. Accordingly, *si* 'and' is not considered a general coordinating device here. Rather, it is considered a sequential coordinating device. Haspelmath (2004: 8) notes that general coordinating devices are often translated as 'and' or '(and) then' because it is difficult to know to what extent the temporal relation is part of the meaning of the clause-linking device or to what extent it derives from the context. The policy adopted in this study is that general coordinating devices that have acquired a specific temporal meaning (e.g., temporal subsequence) are considered 'and then' coordinating devices.

Daga (Dagan)

(4) *sinasin*   *ben*   *wat*   *wan-in*
     cockatoo   decoration   get   give-3SG.SBJ
     'He (the crow) decorated the cockatoo,

     si   *wao*   *anega*   *wa-n-i…*
     and   crow   thus   say-3SG.SBJ-MV
     and the crow said….' (Murane 1974: 177)

A number of languages in the sample convey temporal adverbial relations with LESS-
-GRAMMATICALIZED CLAUSE-LINKAGE PATTERNS. These strategies are semantically non-
-specific. For instance, languages may use an ASYNDETIC PATTERN as a primary strategy for conveying temporal meanings. Asyndetic construction refers to two clauses without any structural element linking them. It is likely that most languages of the world can combine clauses with asyndetic constructions (Noonan & Bavin 1981: 45). However, it is not common that this strategy becomes the primary one for expressing adverbial relations (e.g., 'when', 'because', etc.). An example is found in Koyra Chiini. The primary strategy for denoting 'before' in this language is that of asyndesis. In (5), clauses are not linked with any overt

device. In this construction, the 'before' interpretation arises due to iconicity of sequencing.[2] Another example is attested in Aghu. In this language, the 'until' relation is not directly expressed with any overt linking device, but inferred from iconicity of sequencing (6) (van den Heuvel 2016: 74). In this construction, the linear order of clauses mirrors their temporal order.[3]

Koyra Chiini (Songhay)

(5)	*a-a*	*gar*	*ey*	*fatta*
	3SG-IPFV	find	1SG	exit

'It happens that I had left

	woo	*bine*	*o*	*gar*	*ŋgi*	*ta*	***na***	*tun*.
	DEM	TOP	IPFV	find	3PL	TOP	NEG	arise

before they have arisen.' (Heath 1999: 279)

Aghu (Trans-New Guinea)

(6)	*dii*	*bu*	*bē-dke*	*napi*	*da-xe*.
	sago	DUR	pound-1SG	mother	come-REAL.SG

'I pounded sago until my mother came.' (van den Heuvel 2016: 74)

Another less-grammaticalized clause-linkage pattern is that of GENERAL COORDINATING DEVICES. These devices may be the primary way for conveying different temporal adverbial relations (Bril 2010: 5; Cristofaro 2003: 20-21). General coordinating devices are free or bound linkers, such as 'and' (Haspelmath 2004), that occur in a biclausal construction. In these constructions, a temporal adverbial relation is inferred due to iconicity of sequencing and/or contextual factors (including world knowledge). For instance, the linkage in the Awa Pit example in (7) involves only the general coordinating linker *kit* and the temporal subsequence relation is inferred due to iconicity of sequencing.

Awa Pit (Barbacoan)

(7)	*mana=na*	*tazh*	***kit***	*ii-ma-ti*.
	Maria=TOP	fall	and	die-COMPL-TERM

'After Maria fell over, she died.' (Curnow 1997: 309)

Languages may have more than one strategy for conveying a particular type of temporal relation. In such cases, we have determined for each language which strategy or strategies are

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[2] It is expected that the clause providing the 'before' meaning occurs postposed to the main clause. This stems from the fact that it refers to a situation that occurs posterior to the one in the main clause (Diessel 2008: 470).

[3] It is expected that 'until' clauses occur at the end of the complex sentence construction given that they denote a situation realized after the situation of the first clause (Diessel 2008: 470).

primary, i.e., which strategy or strategies are used significantly more frequently than the others, and we focus only on those strategies for that language. In order to determine the primary strategy or strategies of the languages in the sample, we rely heavily on the authors of the sources consulted for the present study. However, care should be taken here given general observations is one of the most common ways by which the authors of the sources have identified a primary strategy (roughly 50 sources). That is, they explicitly mention that 'X' strategy is more common than others without providing any statistical frequencies. Evans (2003: 654) shows that temporal subsequence in Bininj Gun-Wok (Gunwinyguan) may be conveyed explicitly (i.e., with various types of sequential coordinators, *wanjh* 'and then', *kaluk* 'and then', *yerre* 'and then') or with asyndetic constructions. However, he mentions that the most common strategy in Bininj Gun-Wok is simply to place verbs in the order of occurrence with no explicit marking of the temporal subsequence relation. Another example is found in Abau (Sepik). In this language, 'when' clauses may be encoded with the conjunction *menkin* 'when' or with a construction appearing with *enekwei* 'time' (Lock 2011: 216). However, constructions appearing with *enekwei* 'time' are used less frequently than the conjunction *menkin* 'when'.

There are a number of sources for which the primary strategy has been determined by using statistical frequencies (roughly 150 sources). Hemmilä & Luoma (1987: 222) show, based on a corpus of 35 texts containing over 28,000 words, that in Urim (Torricelli), the sequential coordinators *atom* 'and then' and *pa* 'and then' occur more frequently than asyndetic constructions for conveying temporal subsequence. Therefore, they are the primary strategies for encoding 'after' clauses.

Sometimes the authors of the sources introduce the range of strategies by which a particular temporal relation may be expressed. However, they do not specify the strategy or strategies used significantly more frequently than the others (roughly 18 sources). In this scenario, native speakers and linguistic fieldworkers on a number of languages were consulted to determine the primary strategy.

As can be seen in Table 3, conjunctions, converbs, and 'and then' coordinators are more common than less-grammaticalized patterns in the languages in the sample.

Table 3: Frequency of clause-linkage patterns in the sample[4]

Clause-linkage pattern	'When'	'While'	'After'	'Before'	'Until'
Conjunctions	208 (73.49)	129 (54.89)	101 (35.31)	177 (81.19)	164 (75.22)
Converbs	71 (25.08)	84 (35.74)	77 (26.92)	36 (16.51)	41 (18.80)
'And then' coordinators	0	0	88 (30.76)	0	0
Less-grammaticalized patterns	4 (1.41)	22 (9.36)	20 (6.99)	5 (2.29)	13 (5.96)
Total	283 (100)	235 (100)	286 (100)	218 (100)	218 (100)

[4] Because of rounding, adding up the percentages of the individual types does not always come to 100% in the tables used in this chapter. Note that a number of languages have more than one primary strategy for conveying temporal adverbial relations.

For a number of languages, it was possible to determine the diachronic source of conjunctions, converbs, and 'and then' coordinators. Evidence for a given diachronic source is explicitly discussed by the authors of the grammars, and may come from reconstruction, partial homo-phony, or identity between the source and the target. In what follows, special attention is paid to a number of diachronic sources of conjunctions, converbs, and 'and then' coordinators. However, the discussion of this domain is not exhaustive given that the sources in the sample do not contain a detail discussion of the historical development of these clause--linkage patterns.

Diachronically, in a number of languages, 'when' conjunctions have been derived from nouns meaning 'time' (71/208=34.17%). In Ingush, the temporal noun *xaana* 'time' developed into a conjunction meaning 'when' (8). This is in line with other studies that have shown that relative clauses encoded with head nouns meaning 'time' provide a common source for temporal adverbial clauses (Heine & Kuteva 2002: 298; Heine & Kuteva 2007: 246; Olguín Martínez 2020). Diessel (2019: 106) notes that relative clauses encoded with a head noun meaning time provide a very frequent source for adverbial conjunctions encoding 'when' temporal clauses.[5] In a similar fashion, in many languages in the sample, 'while' conjunctions have been derived from nouns meaning 'time' (23/125=18.40%) and nouns meaning 'duration' (5/125=4%). In Makasae, the conjunction *watu* 'while' has been derived from a noun meaning 'time' (9).

Ingush (Nakh-Daghestanian)

(8) *siexan*   *Ahwmad*   *hwa=chy-veannacha*   **xaana**,
     yesterday   Ahmed   DEIC=N-go.PTCP.OBL   when
     'Yesterday when Ahmed got home,

     bolx   *bezh*   *joallar*   *so*.
     work   do.CVB.SIM   PROG.IMPERF   1SG.SBJ
     I was working.' (Nichols 2011: 605)

Makasae (Timor-Alor-Pantar)

(9) **watu**   *a'a*   *ani*   *sirbisu*   *ere*,   *gi*   na'u   *au*   *mi-mi*.
     CONJ   REL   1SG.SBJ   work   DEM   3SG.SBJ   just   COMPL   sit.SG-RDP
     'He just sits about while I am working.' (Huber 2008: 112)

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[5] The other source of 'when' conjunctions is that of articles (3/208=1.44%). It is well-known that 'when', and other types of adverbial clauses, may be encoded with nominalizations in many languages of the world (Lehmann 1988). Accordingly, they are often marked with the same morphological make-up as noun phrases (Diessel & Breunesse 2020: 311). In particular, they tend to be marked with articles or determiners that one might analyze as particular types of clause linking-devices.

As for 'after' clause-linking devices, it was possible to determine that in five languages (5/77=6.49%), ablative case markers developed into converbs. In Mangarrayi, the ablative case marker -*wana* developed into a converb used for expressing 'after' (10). Ablative markers in sim-ple clause constructions express motion away from, that is, ablative case applies to an entity that, from the speaker's or protagonist's viewpoint, is moving away from. Accordingly, ablative case makers expressing 'after' appear to be part of a more general process whereby spatial con-cepts are used for also indicating temporal concepts (Haspelmath 1997: 66; Kuteva et al. 2019a: 43).

Mangarrayi (Mangarrayi-Maran)

(10)   *ya-ø-yaŋ-gu-**wana***,   *(w)a-ŋa-naya-wu.*
       IRR-3SG-go-DES-CVB   IRR-1SG.3SG-cook-DES
       'After he goes, I want to cook it.' (Merlan 1982: 21)

'And then' devices have been derived from verbs meaning 'to finish' in eighteen lan-guages in the sample (18/88=20.45%). Jonsson (2012: 145) proposes that a series of clauses, such as 'I cleaned the house, (that) finished, I went for a walk' may be the starting point in grammaticalization processes resulting in a clause combining construction equivalent to that in (11). It has been noted that verbs meaning 'to finish' have grammaticalized into 'and then' coordinating devices in various languages around the world. Kuteva et al. (2019a: 177) mention that this grammaticalization pathway seems to be an instance in which process verbs are grammaticalized to markers structuring narrative discourse.

(11)   *I cleaned the house*, (***that***) ***finished***, *I went for a walk* ('I cleaned the house, **and then**
         I went for a walk').

Another source of 'and then' coordinators is that of demonstratives (6/88=6.81%). In Kokota, temporal subsequence is signaled with the coordinator *anlau* 'and then' (12). Dia-chronically, this clause-linkage pattern developed from the demonstrative *an* 'that' and the suffix -*lau*. This suffix is a pragmatic marker primarily (and very commonly) suffixed to demonstratives and deictic loca-tives in noun phrases, and its function is to provide emphasis in a way that indicates that the refe-rent is exactly the entity at issue (Palmer 2009: 77). Demonstratives tend to develop a discourse--deictic use, in which they refer to an adjacent clause or situation (Diessel & Breunesse 2020).

In a number of languages, 'and then' coordinators have been derived from summary tail-head linkage constructions, e.g., the Jamul Tiipay (Yuman) sequential coordinating device *nya-puu-m* 'when-do.thus-DS' (and then) (Miller 2001: 253-254) and the Kewa (Austronesian) sequential coordinator *gu-pu-maa* 'that-do-SEQ' (and then) (Yarapea 2006: 292).[6] For instance, Van Breugel (2014: 247) explains that *ətəkəyməŋ* 'and then' in Atong (Sino-Tibetan) is a grammaticalized form of the verb *ətək*- 'to do like this/that' and was once

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[6] Summary tail-head linkage constructions involve the replacement of the lexical verb of the tail clause by a generic or light verb (see de Vries 2005; Guérin & Aiton 2019 for a more detailed analysis).

used anaphorically in non-finite verbal forms referring to the situation in the preceding clause. The sequential device *ǝtǝkǝymǝŋ* 'and then' seems to come from *ǝtǝk-ǝy-mǝŋ* 'do.like.this/that=ADV=SEQ' (having done like this/that) and seems to have participated in sequential tail-head linkage (see Olguín Martínez 2023 for more examples of this diachronic development).

As for 'before' clauses, in sixteen languages in the database (16/177=9.03%), conjunctions have been derived from a negative marker and another lexical item. For instance, in Bilua, 'before' relations are expressed with the conjunction *puliako* 'before' (12). This clause-linkage pattern originated in three morphemes: the standard negative marker *puli-*, the ligature *a*, and the third person pronoun *-ko* (Obata 2003: 225).

Bilua (Solomons East Papuan)

(12) **puliako**   *nioqa*   *tada=o*   *nio,*   *o*   *ol=a…*

    before   3.DU   depart=NOM   FOC   3SG.M   go=PRS

    'Before they departed, he went…' (Obata 2003: 225)

In Anindilyakwa, the conjunction *nariwiya* 'before' was derived from the standard negative marker *nari-* 'not' and the perlative case marker *-wiya* (Leeding 1989: 490). In Yagua, the combination of the negative morpheme *néé*, the clitic *=tìy*, and the negative morpheme *-míy* has been lexicalized as the conjunction *néétìymíy* 'before' (Payne 1985: 67). Another example is found in Baure. In this language, the basis of the conjunction *moena* 'before' was the verb *-ina-* 'be of use'. The privative prefix *mo-* 'without' was attached and the direct translation of the particle would be '(be of) no use' (Danielsen 2007: 395). From a functional perspective, the development of a 'before' conjunction from a negative marker and another lexical item is not surprising. In this scenario, negative markers cue that the situation of one clause is construed as not yet having taken place at the time of the other clause situation.

From a historical perspective, conjunctions expressing 'until' may develop from verbs. In the sample, it was possible to determine that in seven languages, 'until' conjunctions have been derived from verbs meaning 'to arrive' or 'to reach' (7/164=4.26%). An example is attested in Begak. In this language, 'until' meanings are signaled with the conjunction *sawot* (13). This conjunction developed from a verb meaning 'to arrive' (Goudswaard 2005: 178). The usage of verbs meaning 'to arrive/to reach' in the expression of 'until' can be interpreted as being part of a more general process whereby languages use a spatial metaphor (sometimes called fictitious motion) to refer, not to the motion of an agent, but to the (metaphorical) motion in time of a situation.

Begak (Austronesian)

(13) *da*   *gǝ-tuttug*   *ino*

    PROG   AV-fall.out   yonder

    'Its fur fell out on and on

sawot	*nong*	*a-matay*	*tu*	*bəgko*	*asu*	*di.*
until	OBL	NON.VOL-dead	too	also	dog	over.there

until her friend had no money.' (Goudswaard 2005: 178)

Another diachronic source of 'until' conjunctions is that of locational nouns meaning 'edge', 'border', 'end', or 'limit' (13/164=7.92%). As an example, let us consider Tamil. This language resorts to the conjunction *varai* 'until' for expressing temporal boundary adverbial relations (14). The etymology of this connective is a noun meaning 'end/limit' (Lehmann 1993: 335). Kuteva et al. (2019a: 81-82) mention that this development is attested in various African languages (e.g., Swahili *mpaka* 'border').[7] They point out that the use of locational nouns meaning 'edge', 'border', 'end', or 'limit' in the expression of 'until' is a general process whereby locational nouns give rise to typically spatial or temporal grammatical markers.

Tamil (Dravidian)

(14) | *Kumaar* | *varu-kir-a* | ***varai-**kk-um*, | *naan* | *kaattiru-nt-een*. |
|---|---|---|---|---|
| Kumar | come-PRS-ADJ | CONJ-DAT-INCL | 1SG.SBJ | wait-PST-1SG.SBJ |

‘I waited until Kumar came.' (Lehmann 1993: 335)

With respect to the diachronic sources of converbs, various types of case markers play a role in the expression of 'until'. Allative or lative case markers may develop into converbs used for expressing 'until'. This is attested in three languages in the database (3/41=7.31%). In Udihe, the converb *-tigi* has been derived from a lative case marker.

Udihe (Tungusic)

(15) | *ŋiča* | *aziga* | *sagdi* | *odo-i-**tigi*** | *igi-si-e-ni*. |
|---|---|---|---|---|
| little | girl | big | become-PTCP.PRS-CVB | feed-IPFV-PST-3SG |

‘(The man) used to feed a little girl (his future wife) until she grew up.' (Nikolaeva & Tolskaya 2001: 738)

To sum up, this section has shown that 'when', 'while', 'after', 'before', and 'until' clauses tend to be encoded with conjunctions, converbs, and 'and then' coordinators in the languages in the sample. Moreover, this section has discussed a number of diachronic sources of these clause-linkage patterns. Diachronic information is not explicitly available for a large portion of the languages included in the sample. Accordingly, the present study can make only a modest contribution to the source-oriented explanations in diachronic-typological investigations of temporal clause-linkage patterns.

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[7] It has been proposed that many Eastern African languages have copied the Swahili noun *mpaka* 'border' for expressing 'until' (Mous 2020).

4. Data analysis

In this section, special attention is paid to whether conjunctions, converbs, and 'and then' coordinators tend to be semantically monofunctional or polyfunctional in the languages in the sample (§4.1). Moreover, a detailed discussion of the semantic polyfunctionality patterns of temporal clause-linking devices is provided (§4.2).

4.1. Semantic mono/polyfunctionality of clause-linkage patterns

Conjunctions, converbs, and 'and then' coordinators may be semantically monofunctional or polyfunctional. The example in (16) occurs with the conjunction 'after'. This device is monofunctional in that it is only used for conveying temporal subsequence. For a typical case of a conjunction that is polyfunctional, consider the temporal and causal meanings of 'since' (17) (Hopper & Traugott 2003: 80-81).

(16)   *After we read your novel*, *we felt greatly inspired*.

(17)   a. *I have done quite a bit of writing since we last got together* (temporal).
        b. *Since I have a final exam tomorrow*, *I won't be able to go out tonight* (causal).

Most authors of the sources taken into account in the present study explicitly mention information related to the semantic mono/polyfunctionality of conjunctions, converbs, and 'and then' coordinators. Therefore, this study heavily relies on their explanations. For most grammars, when the authors mention that a clause-linkage pattern is polyfunctional, they also provide morphosyntactic evidence that the semantic polyfunctionality of a clause-linking device is due to conventionalized implicatures and not to pragmatic inferences not (yet) conventionalized (see Kortmann 1997: 91 for a more detailed discussion of this domain). By pragmatic inferences not (yet) conventionalized is meant the following. The example in (16) may implicate: *because we read your novel we felt greatly inspired*. However, Hopper & Traugott (2003: 81) point out that this causal reading is due to a pragmatic inference not (yet) conventionalized. Hetterle (2015: 205) shows that polyfunctional clause-linking devices are subject to specific morphosyntactic constraints. For instance, the English clause-linking device 'since' is polyfunctional in that it can be used for expressing 'after' relations as in (17a) and 'because' relations as in (17b). However, constructions including the temporal and causal 'since' are subject to distinct syntactic constraints (e.g., the temporal reading is only possible when the adverbial clause is in a past tense, but any tense form can appear with the causal reading).

In this section, the following question is explored: cross-linguistically, which types of temporal adverbial clauses tend to be encoded with monofunctional devices disproportionately more often than polyfunctional devices? To explore this question, conjunctions, converbs, and 'and then' coordinators are only taken into consideration.

To the question formulated above, the simplest way is to count the number of mono--functional and polyfunctional clause-linking devices used for encoding each of the temporal clause types in the languages in the sample. To measure the degree to which a clause type is skewed towards semantic monofunctionality or polyfunctionality (and to determine the reliability of this skew), one can then apply a chi-squared goodness-of-fit test. Because the present research seeks to explore the differences particular to each clause type, one chi-squared test for each semantic type of temporal adverbial clause was performed. Once the distribution of the dependent variable for each temporal adverbial clause was obtained (i.e., the *p*-values from the chi-squared tests), we estimated the effect size of the difference by taking the (absolute value of the) base-10 logarithm of the *p*-values.

The first step was to determine the number of monofunctional and polyfunctional clause--linkage patterns per semantic type of temporal clause attested in the languages of the present study. The resulting values are presented in Table 4.

Table 4: Frequency of mono/polyfunctional devices in the present study

Type	Monofunctional devices	Polyfunctional devices	Total
'When' clauses	76 (27.24%)	203 (72.76%)	279 (100%)
'While' clauses	100 (44.84%)	123(55.16%)	223 (100%)
'After' clauses	190 (71.42%)	76 (28.58%)	266 (100%)
'Before' clauses	159 (74.64%)	54 (25.36%)	213 (100%)
'Until' clauses	153 (74.63%)	52 (25.37%)	205 (100%)

The second step was to formulate the hypotheses. H0 postulates that monofunctional and polyfunctional clause-linkage patterns used in the encoding of each type of temporal clause are distributed evenly, meaning that both constructions occur equally often, i.e., 50% of the time. Thus:

H0:   The frequencies of the two variable levels of CONSTRUCTION are identical–if I find a difference in my sample, this difference is just random variation; MONO_devices=POLY_ devices.

H1:   The frequencies of the two variable levels of CONSTRUCTION are not identical; MONO_ devices ≠ POLY_ devices.

The third step was to run the chi-squared goodness-of-fit tests for each type of temporal adverbial clause (assuming 50/50 expected distribution). Table 5 shows the *p*-values for each temporal adverbial clause.

Table 5: *P*-values for each temporal adverbial clause

Type	*P*-values
'When' clauses	x-squared=47.367, df=1, *p*-value=5.887e-12
'While' clauses	x-squared=2.3722, df= 1, *p*-value=1.2e-1
'After' clauses	x-squared=48.857, df =1, *p*-value=2.8e-12
'Before' clauses	x-squared=51.761, df=1, *p*-value=6.27e-13
'Until' clauses	x-squared = 49.761, df=1, *p*-value=1.737e-12

After obtaining the *p*-values from the chi-squared tests of each temporal adverbial clause, we took the base-10 logarithm of each, and then took the absolute value of the logged *p*-values. The results of this analysis can be seen in Table 6. Note that the logged *p*-values help us to have an estimate of the effect size, or how different from a 50/50 split between monofunctional and polyfunctional devices the data are. This transformation has the advantage of indicating strength of association in a more intuitive scale (increasing values indicate increasing degrees of association; the threshold for significance falls at +1.30103). By convention, the direction of association is indicated by the sign of the logged *p*-value: positive values indicate association with monofunctional devices; negative values indicate association with polyfunctional devices.

Table 6: Logged *p*-values for each temporal adverbial clause

Type	Logged *p*-values
'When' clauses	-11.230092
'While' clauses	- 0.908287
'After' clauses	11.560192
'Before' clauses	12.202742
'Until' clause	11.760290

In Figure 1, the x-axis shows the difference between monofunctional and polyfunctional counts. The y-axis shows the absolute value of the effect size. Each semantic type is plotted as a point. Note that 'while' clauses are flexible in that they may be encoded by either mono-functional or polyfunctional devices (with a slight, non-significant trend towards poly-functionality). 'After' clauses, 'before' clauses, and 'until' clauses, tend to be encoded with monofunctional clause-linking devices. 'When' clauses tend to be polyfunctional. The results suggest that 'after', 'before', and 'until' meanings are strongly and similarly associated with monofunctional devices cross-linguistically (all are more than 70% monofunctional). 'While' meanings are ambivalent, and 'when' meanings are strongly encoded with polyfunc-tional devices (only 30% of 'when' clauses are monofunctional, virtually the inverse of 'after', 'before', and 'until').
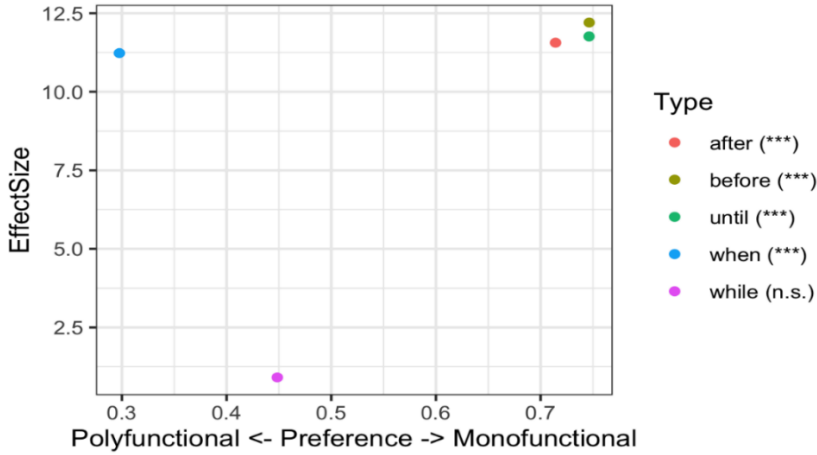
Figure 1. Mono/polyfunctionality of devices encoding temporal adverbial clauses

4.2. Semantic polyfunctionality

Most studies that have addressed the semantic polyfunctionality of temporal clause-linking devices have only taken into account a particular type of device (e.g., Kortmann 1997 only takes into account conjunctions) or two types of devices (e.g. Hetterle 2015 only takes into account conjunctions and converbs). Accordingly, it is not clear whether other devices that have been traditionally disregarded (e.g., 'and then' devices) will show polyfunctionality patterns not attested in previous studies. The question is: do the semantic polyfunctionality patterns attested in the present study align with those documented by other typological studies?

The main assumption is that polyfunctionality patterns in synchronic data reflect paths of semantic development diachronically (Jonsson 2012: 126; Kortmann 1997: 96). It will certainly be enlightening to use a semantic map for exploring the directionality of diachronic change of the polyfunctionality patterns attested in the present research. However, given that the diachronic data are far more difficult to obtain than the corresponding synchronic data, the present research can make only a modest contribution to the understanding of this domain. In what follows, we explore the semantic polyfunctionality patterns attested in the database.

4.2.1. 'When' clauses: Polyfunctional devices

'When' is involved in patterns of polyfunctionality with 9 adverbial relations (Table 7). In total, 'when' clauses are involved in 279 cases of overlap. 'When' constructions realized with polyfunctional devices are more frequently involved with other temporal relations ('while', 'after', 'before', 'until', and 'as soon as') than with non-temporal relations (e.g., 'if', 'because', 'although', and 'where'). Methodologically, if a clause-linkage pattern expresses three relations ('when', 'after', 'until') or more relations, it contributes to the counts and percentages of all of the relations it covers. This is similar to the procedure that has been followed in other typological studies (e.g., Hetterle 2015: 219). For instance, Kortmann (1997: 366) mentions that,

in his investigation, polyfunctional devices may be counted several times, that is, the percentages can be calculated for the total of readings that a device in a relevant language may receive. An example is found in Albanian. In this language, the conjunction *qëkurse* with its readings 'since', 'after', 'as soon as', 'when', 'while', 'as long as' was counted six times as a clause-linking device and the Albanian device *mbasi* was counted twice as a temporal device ('after', 'as soon as') and once as a causal device ('as/because'). This process has also been followed for the temporal clauses discussed in this subsection, and the following subsections.

Table 7: Individual polyfunctional patterns of 'when' devices

Relation	Count	Percentage
'While' relations	105	37.63
'If' relations	93	33.33
'After' relations	30	10.75
'Before' relations	25	8.96
'Because' relations	9	3.22
'Until' relations	8	2.86
'Where' relations	6	2.15
'Although' relations	2	0.71
'As soon as' relations	1	0.35
Total	279	100.00

As is indicated in Table 11, the most common patterns are between 'when' and 'while' (37.63%) and between 'when' and 'if' (33.33%). The overlap between 'when' and 'while' is not surprising in that 'while' constructions along with 'when' have been described as two types of simultaneity (Xrakovskij 2009: 30). 'When' clauses cover a large part of the semantic spectrum of temporal adverbial relations, with the precise reading essentially depending on the discourse context (including Tense-Aspect-Mood) of the construction, and apart from that, on the degree of delicacy one wants to adopt in classifying the relevant reading in a given context (Kortmann 1997: 182). In contrast, 'while' constructions have a specific reference time in that they refer to a length of time (*time during*; Dixon 2009: 10) and can only show a reference time involving situations that occur absolutely or partially simultaneously. Most sources of the languages in the sample explicitly indicate that 'while' meanings are derived from 'when' meanings. This suggests that an unspecific temporal meaning may develop into a specific temporal meaning (i.e., 'when' > 'while').

The second most frequent pattern is between 'when' and 'if'. It has often been suggested that clause-linking devices encoding 'when' clauses are often used for expressing generic/habitual conditional meanings (e.g., *When flowers are kept in the heat, they quickly wither away= If flowers are kept in the heat, they quickly wither away*; Comrie 1986: 82; Cristofaro 2003: 161). This is in line with Kortmann (1997: 192) who demonstrates that if a marker of 'when' clauses develops an additional use as a marker of a non-temporal relation, this relation is most likely to be 'if'. Most sources in the languages in the sample show that 'when' develops

into 'if' (i.e. 'when' > 'if'). This follows the tendency of less abstract meanings developing into more abstract ones. In this scenario, a 'when' relation is pragmatically enriched by the implicature that one of the situations is also the condition of the other situation (Hetterle 2015: 256).

The polyfunctional patterns attested in the present investigation are almost identical to those found in other cross-linguistic studies (e.g., Hetterle 2015: 219; Kortmann 1997: 181). However, there are two overlaps that have not been explored before.

First, there are languages in which a clause-linking device is used for expressing 'when' and 'where'. A case in point is attested in Meryam Mir. In this language, the conjunction *náde* can also be employed for denoting 'where'. The 'when' interpretation is only possible when the dependent clause is preposed to the main clause (18). On the other hand, a *náde*-construction indicates 'where' when the dependent clause appears postposed to the main clause (19) (Piper 1989: 199). From a diachronic perspective, it is likely that the direction of development has been from spatial via temporal, that is, from a concrete to a more abstract meaning (Kortmann 1997: 96). In this regard, space is stable and concrete, time is always ongoing and less concrete than space (Jonsson 2012: 126). This is also indicated by the sources of the languages consulted for the present study.

Meryam Mir (Western Fly)

(18) **náde**   *mitkat*   *b-er-er*,
      CONJ   a.lot   PL-become-PRS.IPFV
      'When there were a lot (of fish caught),

      wi-ge-t-áys-lare…
      3PL-DEIX-carry-PL.OBJ-PRS.IPFV.PL
      they would bring (them)…' (Piper 1989: 199)

(19) *máyk-em*   *able*   *mekir-em*
      close-ALL   DET   almond.tree-ALL
      '(They crawled up close) to the almond tree

      náde   *ge*   *sarup*-ira   *sárik*   *kep-kem*   *da-ra-rem*.
      CONJ   DEIX   castaway-GEN   bow   arrow-ASSOC   3-PL-be.sticking
      where the castaway's bow and arrow were sticking up.' (Piper 1989: 199)

Second, there is one language in the sample in which a clause-linking device conveys 'when' and 'as soon as'. The overlap between 'when' and 'as soon as' has been documented for Somali. In this language, 'when' constructions are encoded with the conjunction *markii* (20). This clause-linkage pattern can also indicate 'as soon as' (21). The development of 'when' into 'as soon as' can be explained by the fact that there are contexts in which 'when' may implicate immediate temporal subsequence. Accordingly, the meaning of 'when' can become enriched inferentially by the implicature that the situation of the main clause immediate follows the situation of the dependent clause.

Somali (Afro-Asiatic)

(20) **markii**   uu   qol-kii   ká   baxáy,
     CONJ   3SG.SBJ   room-the   from   went
     'When he left the room,

     wáxaan   kú   idhi   nabád   gélyo.
     1SG.SBJ   to   said   peace   enter.CAUS.OPT
     I said goodbye to him.' (Saeed 1999: 218)

(21) is-la   **markii**   uu   tegáy,   sháqàan   bilaabay.
     REFL-with   CONJ   3SG.SBJ   went   work.1SG.SBJ.FOC   began
     'As soon as he left, I began working.' (Saeed 1999: 218)

4.2.2. 'While' clauses: Polyfunctional devices

'While' is involved in patterns of polyfunctionality with 12 adverbial relations, as is illustrated in Table 8. In total, 'while' is involved in 164 cases of overlap. Note that 'while' shows overlaps with other temporal relations (e.g., 'when', before', 'after', 'until', 'since', and 'as soon as') and with non-temporal relations (e.g. 'if', 'although', 'in order to', 'without', 'because', and 'where'). Of these, 'while' shows more overlaps with other temporal relations. In particular, the most common overlap is with devices that also cover 'when' (64.02%). The polysemy with 'before' is the second most common type (15.24%).

Table 8: Individual polyfunctional patterns of 'while' devices

Relation	Count	Percentage
'When' relations	105	64.02
'Before' relations	25	15.24
'After' relations	8	4.87
'If' relations	6	3.65
'Although' relations	6	3.65
'In order to' relations	4	2.43
'Until' relations	3	1.82
'Without' relations	2	1.21
'Because' relations	2	1.21
Temporal 'since' relations	1	0.60
'Where' relations	1	0.60
'As soon as' relations	1	0.60
Total	164	100

Kortmann (1997: 192) mentions that if a marker of 'while' clauses develops an additional use as a marker of a non-temporal relation, this relation is most likely to be 'although'. The results of the present study echo Kortmann's results. However, it is also interesting to observe that another non-temporal meaning that 'while' devices may develop is that of 'if'.

As was discussed in §4.2.1, the overlap between 'when' and 'while' is not surprising in that 'while' and 'when' constructions have been described as two types of simultaneity. The second most common pattern is between 'while' and 'before'. In this scenario, negative markers play an important role in that they serve as morphosyntactic material aiding in the 'before' interpretation. From a diachronic perspective, 'before' meanings are derived from paraphrases involving 'while' and a negative marker or a negative adverb(ial) 'not yet' ('before' is roughly the same as 'while not yet'; Wälchli 2018). In Motuna, 'before' clauses appear with the converb -*juu* (22). The dependent clause must be marked with the negative marker *toku*. The Converb -*juu* is polyfunctional and can be used for expressing 'while' when the dependent clause shows positive polarity (23). The change from 'while' to 'before' seems to be motivated by the inference that 'while not yet' implies that the situation of the main clause happens before the situation expressed in the dependent clause. Put another way, in this scenario, 'while' does not show a reference time involving situations that occur absolutely or partially simultaneously. Instead, it is employed to indicate a situation that has not yet been realized when the main clause situation takes place.

Motuna (East Bougainville)

(22)   *tii*   **toku**   *umuu-**juu***,   *na-mar-a-a-ni…*
       there   NEG   come.1PL.EXCL-CVB   say.to-1PL.EXCL.OBJ-3PL-REM.PST-DU
       'Before we came there, they said to us…' (Onishi 1994: 476)

(23)   *ti*   *pa-na*   *ti-ki*   *poo'-ki*   *kuuto-woi-**juu***,
       ART.F   3SG.POSS-wife   ART-ERG   under.tree-ERG   be.waiting-3SG-CVB
       'While his wife was waiting under the tree,

       Emmai   *koto*   *kiin-u-u-ng*.
       Emmai   up   climb-3SG-REM.PST-M
       Emmai climbed up.' (Onishi 1994: 475)

The polyfunctional patterns documented in the present work are almost identical to those attested by Hetterle (2015: 220) and Kortmann (1997: 181). However, there is one polyfunctional pattern not described in their research. There are two Afro-Asiatic languages (i.e., Beja and Sidaama) in the sample in which a clause-linking device is used for indicating 'while' and 'without' (also known as negative concomitance). An example of this pattern can be found in Sidaama. In this language, 'while' and 'without' are expressed with -*nni*. The 'without' interpretation only arises when the dependent clause appears with the negative marker -*kki* (25). The sources of the sample indicate that 'without' has been derived from

'while' ('while' > 'without'), indicating a direction of development from a concrete to a more abstract meaning. The development of 'while' into 'without' can be explained by the fact that 'without' involves a simultaneous situation in which 'p' does not accompany 'q' (see Olguín Martínez & Peregrina Llanes 2023). This situation more often than not runs counter to expectation, or is simply regarded as remarkable (e.g., 'he went past me without greeting me'). 'Without' constructions in these languages appear with obligatory negative markers. Accordingly, from a diachronic perspective, 'without' meanings have been derived from paraphrases involving 'while' and a negative marker ('without' is roughly the same as 'while not').

Sidaama (Afro-Asiatic)

(24)   *sagalé   ra'-is-i-d́-d́-a-**nni***
        food   become.cooked-EP-CAUS-EP-MID-3SG.F-while
        'While she was cooking,

        angá   gii-d́-i-t-u.
        hand   burn-MID-3SG.F-PFV-3SG.F
        she burned her hand.' (Kawachi 2007: 381)

(25)   *keeš-i-tto-**kki-nni***   *amo.*
        stay.long-PFV-2SG.M-NEG-without   come.IMP.2SG
        'Come without staying long.' (Kawachi 2007: 382)

4.2.3. 'After': Polyfunctional devices

'After' is involved in patterns of polyfunctionality with 10 adverbial relations, as is shown in Table 9. In total, 'after' is involved in 103 cases of overlap. It is worth noting that 'after' is involved in more overlaps with different types of non-temporal relations (i.e. 'as a result', 'because', 'if', 'although', 'in order to', and 'lest') than with other types of temporal relations (i.e. 'when', 'before', 'while', and 'until'). The most common overlaps are between 'after' and 'when' (29.12%), between 'after' and 'before' (19.41%), and between 'after' and 'as a result' (16.50%). One comment on the polyfunctionality pattern between 'after' and 'as a result' is in order here. Kortmann (1997: 192) proposes that if a clause-linking device encoding 'after' clauses develops an additional use as a marker of some non-temporal relation, this relation is most likely to be 'because'. The results of the present study are not in line with Kortmann's proposal, in that the most frequent connection is between 'after' and 'as a result' in the present study. One potential reason why the results of the present investigation are different from those attested in Kortmann's study stems from the fact that we take into account 'and then' devices. This is one of the most common kinds of semantic polyfunctionality that 'and then' devices have developed in the languages in the sample.

Table 9: Individual polyfunctional patterns of 'after' devices

Relation	Count	Percentage
'When' relations	30	29.12
'Before' relations	20	19.41
'As a result' *relations*	17	16.50
'While' relations	8	7.76
'Because' relations	7	6.79
'Until' relations	7	6.79
'If' relations	5	4.85
'Although' relations	4	3.88
'In order to' relations	4	3.88
'Lest' relations	1	0.97
Total	103	100.00

There are two polyfunctional patterns attested in the sample that have not described by previous typological studies (e.g., Hetterle 2015: 220; Kortmann 1997: 181; Martowicz 2011: 107--108). First, there are languages that employ the same device for expressing 'after' and 'until'. In Urim, 'after' and 'until' are expressed with the clause-linking device *pa*. In (26), the temporal subsequence relation is signaled with *pa*. To indicate that the action of the main clause continues until something else happens or until the end of the situation of the main clause is achieved, the verb of the main clause must be repeated several times (Hemmilä & Luoma 1987: 26), as in (27). In this scenario, the meaning of 'after' has become enriched inferentially by the implicature that the dependent clause marks the endpoint of a situation expressed in the main clause.

Urim (Torricelli/Urim)

(26) *men*   *lap*   *namung*   **pa**   *plalng*   *apis*.
      1PL.EXCL   roast.REAL   banana   CONJ   finish   scrape.REAL
      'We roasted the bananas and then scraped the ashes off.' (Hemmilä & Luoma 1987: 80)

(27) *men*   *ak*   *yikal*   **or-or-or-or-or-or**,
      1PL.EXCL   do.REAL   bow   hit-hit-hit-hit-hit-hit
      'I kept hitting and hitting it with the bow,

      pa   *amo*.
      CONJ   die.REAL
      until it died.' (Hemmilä & Luoma 1987: 26)

Second, there is one language in the sample that employs the same device for forming 'after' clauses and avertive 'lest' clauses. In Gaagudju, 'after' and 'lest' are expressed with *baleeru*. The 'after' interpretation arises when the main clause appears in any tense,

as in (28). However, the 'lest' interpretation is only possible when the dependent clause of a *baleeru*-constructions is marked with the evitative marker -*ya*, as in (29). The evitative marker merely asserts that the predication is possible (Harvey 2002: 251). The semantic affinity between 'after' and 'lest' can be explained as follows. An 'after' construction involves a sequence of two clauses in which the situation of the main clause happens after the situation expressed in the dependent clause. 'After' can be pragmatically enriched by the implicature that the dependent clause may invoke an undesired world (i.e., undesirable situation) that can be avoided by the situation described in the main clause.

Gaagudju (Isolate)

(28)   …**baleeru**   *ma-rraama*   *djaamu*.

and.then   1SG-get.FUT   tucker

'…And then I will get some tucker.'

Ma-nee-nda   *mananggaarr*   *nji-n-baloolburrbu*.

2SG-FUT-eat   that   2SG-FUT-full.up

'You can eat it and then you will be full up.' (Harvey 2002: 377)

(29)   *gooyida*   *njing-gaama-y*   *ilaawala*

NEG.IMP   2SG-say-PRS   little

'Don't say (that), little boy!

baleeru   *nji-n-ngeewi*   *yunggaalja*   *nji-nbuu-ya*.

lest   3SG-hear-AUX   devil   3SG-kill-EVIT

lest a devil hear you and kill you.' (Harvey 2002: 375)

4.2.4. 'Before' clauses: Polyfunctional devices

'Before' is involved in patterns of polyfunctionality with 5 adverbial relations (Table 10). In particular, 'before' shows overlaps with other temporal relations (e.g., 'while', 'when', 'after', and 'until'). The most common overlaps are between 'before' and 'while' (32.46%), between 'before' and 'when' (27.27%), and between 'before' and 'after' (25.97%). There is only one overlap with a non-temporal relation that 'before' clauses show. 'Before' clauses may overlap with avertive 'lest' clauses. This is an interesting finding in that it has been proposed that if a marker used in the expression of 'before' develops an additional use as a marker of some non-temporal meaning, this relation is most likely to be preference (e.g., 'rather than go there by plane, I would take the slowest train'; Kortmann 1997: 192).[8]

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[8] Preference constructions are a type of adverbial construction in which of two alternatively possible situations *p* and *q*, *q* is preferred (by the generally volitional subject referents) and renders *p* unnecessary or improbable (Kortmann 1997: 89).

Table 10: Individual polyfunctional patterns of 'before' devices

Relation	Count	Percentage
'While' relations	25	32.46
'When' relations	21	27.27
'After' relations	20	25.97
'Until' relations	6	7.79
'Lest' relations	5	6.49
Total	77	100.00

The polyfunctional patterns attested in the present investigation are almost identical to those documented by Hetterle (2015: 222) and Kortmann (1997: 181). However, there is one polyfunctional pattern not described in their studies. There are 5 languages in the sample in which the same device is used for expressing 'before' and 'lest'. The authors of the sources indicate that 'before' clauses developed into avertive 'lest' clauses ('before' > 'lest'). In particular, this seems to be common in cases in which a 'before' clause shows an implicature that an undesirable situation is to be avoided (see Tahar 2021 for a more detailed discussion of avertive 'before' clauses). Put another way, the meaning of 'before' became enriched inferentially by the implicature that the dependent clause invokes an undesired world that can be avoided by the action described in the main clause. An example illustrating this development is attested in Virgin Islands Dutch Creole. Kuteva et al. (2019b: 864) mention that this language offers a semantically transparent example of how a structure which initially involved a 'before' clause (30), gave rise over time, to the avertive 'lest' construction in (31).

Virgin Islands Dutch Creole

(30) *ju*   *fo*   *bli*   *een*   *jaa*   *mi*   *ons*,
      2SG   MOD   stay   INDEF   year   with   1PL
      'You must stay with us for one year,

      fo   *ju*   *nee*   *am*   *fa*   *ons*.
      CONJ   2SG   take   3SG   of   1PL
      before you take her from us.' (Kuteva et al. 2019b: 864; cf. Van Sluijs 2015)

(31) *dan*   *Anáánsi*   *a*   *ho*   *fo*   *loo*   *bet*   *padún*,
      then   Anansi   PST   have   for   go   ask   pardon
      'Then Anansi had to ask for forgiveness,

      fo   *sini*   *du*   *am*   *a*   *fort*.
      CONJ   3PL   do   3SG   LOC   prison
      lest they put him in prison.' (Kuteva et al. 2019b: 864; cf. Van Sluijs 2015)

4.2.5. 'Until' clauses: Polyfunctional devices

'Until' is involved in patterns of polyfunctionality with 8 adverbial relations (Table 11). In total, 'until' is involved in 65 cases of overlap. 'Until' shows more overlaps with other temporal relations ('when', 'after', 'before', 'while', and 'as long as') than with non--temporal relations (e.g., 'in order to', 'as a result', and 'where). The most frequent poly-functionality pattern is between 'until' and 'in order to' (44.61%). This is an interesting finding in that Hetterle (2015: 223) shows that if a clause-linking device encoding 'until' clauses develops an additional use as a marker of some non-temporal relation, this relation is most likely to be 'as a result'. The overlap between 'until' and 'in order to' has been explored in other typological studies. For instance, Schmidtke-Bode (2009: 106) shows that this overlap is attested mainly in African languages, such as Noon, Koyra Chiini, and Khoekhoe. In contrast, the overlap between 'until' and 'in order to' is mainly attested in the Australian languages of the sample of the present research (e.g., Miriwung; Kofod 1978: 142; Wagiman; Cook 1987: 131; Wambaya; Nordlinger 1993: 86).

Table 11: Individual polyfunctional patterns of 'until' devices

Relation	Count	Percentage
'In order to' relations	29	44.61
'When' relations	8	12.30
'After' relations	7	10.76
'Before' relations	6	9.23
'As a result' relations	6	9.23
'While' relations	3	4.61
'As long as' relations	3	4.61
'Where' relations	3	4.61
Total	65	100

The overlaps of 'until' documented in the present research are almost identical to those found in Hetterle (2015: 223) and in Kortmann (1997: 181). One exception is the polyfunctionality pattern between 'until' and 'where'. In three languages in the sample, 'until' and 'where' are expressed with the same device. An example is attested in Ket. In this language, 'until' clauses and 'where' clauses are realized with the conjunction *baŋdiŋa*, as in (32) and (33). Nefedov (2015: 180) mentions that "in addition to marking temporal boundary, *baŋdiŋa* can mark locative relations. In the latter case, it requires the presence of a correlative element in the main clause like, for example, *tuniŋa* 'there'." Accordingly, 'where' meanings are distinguished from 'until' meanings by *tuniŋa* 'there', as can be seen in (33).

Ket (Yeniseian)

(32) ū   ab-iŋa   d-ik-s-bess   **baŋdiŋa**,
      1SG   1SG.POSS-DAT   1SG-here-NON.PST-move   CONJ
      'Until you come to me,

      ād   kiséŋ   as   di-k-a-doq.
      1SG   here   FUT   1SG-THEM-NON.PST-live
      I will be living here.' (Nefedov 2015: 181)

(33) tib   du-ses-o-l-ta   **baŋdiŋa**,
      dog   3SG-place-PST-PST-be.in.position CONJ
      'Where the dog sat,

      būŋ   **tuniŋa**   du-ik-n-bes-in.
      3PL   there   3PL-here-PST-move-PL
      they came.' (Nefedov 2015: 181)

As was noted above, the most frequent overlap is between 'until' and 'in order to'. Most authors of the sources mention that 'in order to' developed from 'until' (i.e., 'until' > 'in order to'), indicating a direction of development from a concrete to a more abstract meaning. The conceptual factors that motivate this semantic affinity could be explained as follows. Temporal clauses expressing terminal boundary mark the endpoint of a situation expressed in the main clause. 'Until' can be pragmatically enriched by the implicature that the dependent clause is also the purpose of the situation encoded in the main clause (e.g., 'I did it until she felt better'). In this scenario, the situation of the main clause is performed with the intention of obtaining the realization of the situation of the dependent clause.

There are other less frequent polyfunctionality patterns (i.e., between 'until' and 'as long as').[9] Of these, the authors of the sources mention the directionality of development of two overlaps. First, 'where' meanings develop into 'until' meanings (i.e., 'where' > 'until'). This indicates that the direction of development has been from space to time. Second, 'until' meanings develop into 'as a result' meanings (i.e., 'until' > 'as a result'). This has not gone unnoticed and echoes Hetterle (2015: 261), who mentions that 'until' and 'as a result' are likely to be related via the context-dependent conventionalized implicature that the endpoint specified in the 'until' clause is also the result or consequence of the main clause situation.

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[9] Kortmann (1997: 178) notes that 'until' devices may be polyfunctional with 'as long as'. He explains that this link stems from the fact that the two relations can to some extent be viewed as complements of each other. For 'as long as' relations, the dependent clause situation opens up a time interval for the whole of which the situation of the main clause is true. On the other hand, 'until' relations introduce the endpoint of the time interval at which the situation of the main clause is true. This polyfunctionality has also been noted by Wälchli (2018: 190). This is attested in almost all modern Slavic languages, Hindi, Maithili, Hungarian, and Mordvin.

5. Final remarks

The present paper has set out to examine 'when', 'while', 'after', 'before', and 'until' clauses in a variety sample of 218 languages. A chi-squared goodness-of-fit test has shown that 'after', 'before', and 'until' meanings are strongly and similarly associated with mono-functional devices cross-linguistically. 'While' meanings are ambivalent, and 'when' meanings tend to be encoded with polyfunctional devices. In addition, the paper has analyzed the polyfunctionality patterns of temporal adverbial clause-linking devices. While the semantic polyfunctionality patterns attested in the present research align, for the most part, with those documented by other typological studies, there are a number of patterns that have been neglected in the typological literature, such as the polyfunctionality pattern between 'when' and 'where', between 'when' and 'as soon as', between 'while' and 'without', between 'after' and 'until', between 'after' and 'lest', between 'before' and 'lest', and between 'until' and 'where'.

There are a number of areas relevant to the study of temporal adverbial clauses that we could not address to keep the scope of the research manageable. Accordingly, they remain to be investigated by future studies and in what follows we mention some of these fruitful areas. First, as was shown in the paper, sometimes the clause-linking device may appear either in the first or second clause. In these cases, it would be interesting to explore whether there are any correlations between the position of the clause-linking device and its mono/polyfunctionality.

Second, another candidate for larger-scale future investigations is the number of clause-linking devices that may appear in a construction. In various languages in the sample, the complex sentence construction may appear with two clause-linking devices. Interestingly, one of the devices is always optional. It remains an open task to explore the range of factors that lead to this optionality.

Third, the areality of temporal adverbial clause-linkage pattern is another area for future research. It remains to be analyzed how these patterns spread and the mechanisms involved in their diffusion. The more we learn about individual languages and about what is common and rare cross-linguistically, the more adept we should become at recognizing areal patterns and the mechanisms which create them.

Needless to say, much remains to be learned about temporal adverbial clauses in terms of their synchronic functions and how they develop diachronically. However, the present work has hopefully paved the way for a better understanding of some domains related to the form and function of temporal adverbial clauses. It is hoped that the questions explored in this research bring us closer to a deeper understanding of temporal adverbial clauses.

Abbreviations

1=first person, 2=second person, 3=third person, ABL=ablative, ABS=absolutive, ACC=accusative, ADJ=adjective, ADNZ=adnominalizing, AFF=affirmative, AGR=agreement, ALL=allative, ART=article, ASP=aspect, ASSOC=associative, AUX=auxiliar, AV=actor voice, BND=bound root, CAUS=causative, CHD=change of direction, CL=classifier, COMIT=comitative, COMPL=completive, CONJ=conjunction, CONT=continuous, COR=core, CVB=converb, DAT=dative, DEF=definite, DEIC=deictic, DEIX=deixis, DEM=demonstrative, DES=desiderative, DU=dual, DUR=durative, EMOT=emotive, EP=epenthesis, ERG=ergative, EVID=evidential, EVIT=evitative, EXCL=exclusive, F=feminine, FOC=focus, FUT=future, GEN=genitive, HAB=habitual, IMPERF=imperfect, INCL=inclusive, INSTR=instrumental, INTR=intransitive, IPFV=imperfective, IRR=irrealis, LINK=linker, LOC=locative, M=masculine, MID=middle, MOD=MODAL, MV=medial verb, N=noun, NEG=negative, NMLZ=nominalizing, NOM=nominative, OBJ=object, OBL=oblique, OPT=optative, PERF=perfect, PFV=perfective, PL=plural, POSS=possessive, PROG=progressive, PRS=present, PST=past, PTCP=participle, RDP=reduplication, REAL=realis, REFL=reflexive, REM=remote, SBJ=subject, SE=sentence ender, SEQ=sequential, SG=singular, SIM=simultaneous, SS=same subject, SUPERESS=superessive, TERM=terminative, THEM=thematic, TOP=topic, TRANS=transitive, VOL=volitional, VS=verbal stem marker.

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