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Evidential-temporal interactions do not (always) come for free☆

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ABSTRACT

Evidentials are usually assumed to encode the speaker's evidence source. However, some authors propose that evidence source can be derived from temporal information elsewhere in the sentence (e.g., Chung, 2007, Lee, 2013, Koev, 2017, Bowler, 2018, Speas, 2021). We argue that evidence source cannot always be derived from temporal information. Using data from five languages, we propose that evidentials can lexically restrict the time the evidence was acquired. Evidentials can do this independently of other temporal marking, and they sometimes encode both temporal and evidential information.

We show that English 'apparently' and 'seem', Japanese indirect 'yooda' and reportative 'sooda', and St'at'imcets (Lillooet; Salish) perceived-evidence 'an' all require that the earliest time their prejacent becomes true, EARLIEST(p) (Beaver and Condoravdi, 2003) precedes or coincides with the Evidence Acquisition Time. Conversely, English epistemic 'should' and German epistemic 'sollte' require EARLIEST(p) to follow EAT. A third group encodes no temporal restrictions: English epistemic 'must', St'at'imcets inferential 'k'a' and reportative 'ku7', and Gitksan (Tsimshianic) inferential 'ima' and reportative 'gat'. Comparing temporal with nontemporal evidentials supports the view that a temporal component is hardwired for the former set. The fact that temporal contributions cross-cut evidential ones shows that one cannot be reduced to the other.

1. Introduction

Traditionally, evidentials are defined as expressions that encode the type of evidence the speaker's utterance is based on (Aikhenvald, 2004, among others). However, much recent work has argued that the interpretation of some evidentials interacts with, or depends on, the tense and aspect in the rest of the sentence (Fleck, 2007; Chung, 2007; Koev, 2011, 2017;

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Smirnova, 2011, 2013; Lee, 2013; Bowler, 2018; Johnson, to appear, among others). Increasingly, some authors are arguing that in such cases, the evidence source does not even need to be hardwired into the lexical entry of the relevant morpheme, but can instead be *derived* from the temporal/aspectual relation (e.g., Koev, 2017; Bowler, 2018; Speas, 2021).

In this paper we argue that this last claim is not always correct. We argue that evidentials can lexically encode information about the time the speaker acquired their evidence for the truth of the prejacent proposition. They can do this without relying on temporal marking elsewhere in the sentence, and they sometimes must encode *both* temporal *and* evidence source information. Thus, we argue that some evidentials enforce, as part of their lexical entry, a particular relation between the Evidence Acquisition Time (EAT) and the temporal denotation of the prejacent. Our proposal entails that for this type of evidential, there is no way to derive the type of evidence from the temporal relation.

The empirical basis of our proposals comes from the temporal contributions of indirect evidentials in five languages from four families: English (Indo-European), German (Indo-European, Central Europe), Japanese (Japonic, Japan), St'át'imcets (a.k.a. Lillooet; Salish, British Columbia), and Gitksan (Tsimshianic, British Columbia). Our analysis is driven in part by empirical differences between the evidentials in our study and those discussed in prior literature. Many of the evidentials that have so far been reported to encode temporality seem to provide the Evidence Acquisition Time as a new evaluation time for the prejacent proposition; a co-occurring tense then specifies the temporal relation between EAT and the temporal denotation of the prejacent. We call these evidentials 'temporal evidentials with tense'.

Our finding is that there are temporal evidentials *without* tense: some evidentials encode a temporal relation between EAT and the prejacent's temporal denotation that is fixed and independent of the prejacent tense. We argue that English inferential *apparently* and *seem*, the Japanese indirect evidential *yooda* and reportative *sooda,* and the St'át'imcets perceived-evidence inferential *an'* all require that the earliest time their prejacent p becomes true, EARLIEST(p) (cf. Beaver and Condoravdi, 2003) comes at least as early as EAT. Thus, these evidentials encode EARLIEST(p) $\leq$ EAT, regardless of the tense of the prejacent. Meanwhile, English epistemic *should* and the German epistemic modal *sollte* encode the opposite relation, EAT < EARLIEST(p).[1] We argue that these temporal constraints cannot be reduced to a causation analysis based on Davis and Hara (2014), whereby the prejacent event is required to cause the evidence, or vice versa.

In addition to evidentials that encode temporal constraints, we also investigate evidentials that encode *no* temporal restrictions: the English epistemic modal *must*, St'át'imcets inferential *k'a* and reportative *ku7,* and Gitksan inferential *ima* and reportative *gat.* Comparing temporal evidentials with non-temporal ones supports the view that a temporal component is hardwired into the lexical semantics of the former set. We claim that the variation in temporal contributions can be captured by a parameter [EAT-anterior/posterior] that governs whether EAT precedes or follows EARLIEST(p).

The paper is structured as follows. Section 2 briefly surveys relevant prior literature on evidentials with temporal contributions. Section 3 argues that there are evidentials in English, Japanese, St'át'imcets and German that encode temporality but are independent of tense. These evidentials encode a fixed temporal relation between EAT and the prejacent.

Section 4 formalizes the evidentials' temporal contributions. Section 5 claims, through comparison with evidentials that do *not* specify the relation between EAT and EARLIEST(p), that the temporal contributions of the evidentials examined in Section 3 are hardwired into their lexical semantics, rather than being derivable from independent factors. Section 6 shows that the temporal variation seen with inferential evidentials also arises for reportatives. Section 7 proposes a parameterization of the temporal variation with a parameter [EAT-anterior/posterior]. It also introduces the idea that the temporal relation between EAT and EARLIEST(p) may be a semantic building block in the sense of von Fintel and Matthewson (2008) (cf. also Hale, 1986): a piece of meaning, potentially universally available, that can recur in different parts of the syntactic spine.

2. Evidentials with temporal contributions: prior literature

Several previous authors have argued for evidentials that make temporal contributions (see references above). A number of influential studies deal with the evidential *-l-* in Bulgarian (Indo-European, South-eastern Europe), including Izvorski (1997), Koev (2011, 2017), and Smirnova (2011, 2013). *-l-* is a participial morpheme that appears when verbs inflect into evidential forms.[2] Purely for reasons of space, we illustrate by focusing on one particular analysis of Bulgarian: that of

[1] As will be obvious from the list of elements we discuss, we adopt a broad definition of 'evidential' that encompasses not only grammaticized, obligatory morphemes occurring in paradigms (such as are focused on by e.g., Aikhenvald 2004), but also elements that are traditionally termed epistemic modals or adverbials. This is driven by attested semantic parallels between such elements across languages. Authors who analyze epistemic modals as encoding evidential meaning include Swanson (2008), von Fintel and Gillies (2010), Matthewson (2015b), Matthewson and Truckenbrodt (2018), among others.

[2] While *-l-* is often analyzed as a marker of indirect evidentiality (e.g., Izvorski 1997, among many others), Smirnova argues that it can also express (certain types of) direct evidence when it is used as a mirative marker (a marker that expresses the speaker's surprise). We focus on its temporal contribution here.

Smirnova (2013). Note that Arregui et al. (2017) also discuss Bulgarian evidentials and propose a quite different analysis; we return to this briefly in Section 7.

Smirnova argues that the evidential *-l-* makes a temporal contribution: it functions to change the evaluation time of the prejacent clause. Specifically, in a clause containing *-l-*, the evaluation time of the prejacent is provided by the Evidence Acquisition Time. This has the effect that the tense on the verb relates the prejacent's Reference Time (RT) not to the Utterance Time (UT) as is usual, but to EAT. An example is given in (1).[3,4]

(1) (You are hosting a party at your house. Your roommate Maria promised to be at the party, but she is not here. When you check Maria's calendar, you see that she planned to spend the evening writing her book. You infer that right now she is sitting in the library and writing her book. A week later, when a friend of yours asks you why Maria did not show up at the party, you say:)
Maria **piše-l**-a / # **pisa-l**-a kniga.
Maria write.IPFV.**PRES-EVID**-FEM / # write.IPFV.**PST-EVID**-FEM book
'(Lit.) Maria is / # was writing a book.' [I inferred] (Bulgarian; Smirnova (2013:498))

Here, the prejacent event (Maria writing a book) is in the past. However, the past-tensed variant is unacceptable, and the present-tensed variant is felicitous. The (in)felicity in (1) follows if the tense of the prejacent is evaluated relative not to the UT, but to EAT. EAT is the time at which the speaker checked Maria's calendar, and the prejacent event is ongoing at this time. This explains both the felicity of the present-tensed variant and the infelicity of the past-tensed one.

The claim that *-l-* requires EAT to be the evaluation time is further supported by (2), which contains future marking:

(2) (In the morning, Ivan told you that Maria would spend the afternoon writing a portion of her book. In the evening, when your friend asks you what Maria was doing in the afternoon, you say:)
Maria **štja-l**-a da piše kniga.
Maria **FUT-EVID**-FEM SBJV write.IPFV.3SG.PRES book
'Maria would be writing a book.' [I heard] (Bulgarian; Smirnova (2013:497))

The prejacent event is Maria's writing a book, which is located in the past (the afternoon) with respect to the utterance time (the evening). If the prejacent were evaluated relative to UT, (2) would be infelicitous, because the future-marked prejacent requires the prejacent event to follow the evaluation time. However, the prejacent event *is* in the future with respect to EAT (the time the speaker heard the report). Therefore, the felicity of the future auxiliary is explained by assuming that the prejacent is evaluated with respect to EAT.

From these observations, Smirnova (2011, 2013) concludes that *-l-* introduces EAT to the prejacent as a new evaluation time, and the tense on the prejacent verb locates the reference time with respect to EAT. So, when *-l-* combines with past tense, it requires EAT to follow RT; when it combines with future, it requires EAT to precede RT. Thus, *-l-* is a temporal evidential with tense.[5]

Similar proposals for what we term 'evidentials with tense' have been made by Lee (2013) for the Korean evidential *-te* (see also Chung, 2007); Lee argues that this evidential introduces EAT as a new evaluation time for the purpose of tense.

Another thread of research on evidential-temporal interactions claims that evidential information (in other words, what types of source an evidential encodes) is not even separately encoded, but is derivable from temporal and/or aspectual information. Such proposals have been advanced, for example, by Koev (2017) for Bulgarian, Bowler (2018) for Tatar (Turkic), and Speas (2021) for Matses (Panoan). There are also claims that the relation goes in the opposite direction: Pancheva and Zubizarreta (2019) argue that temporality is derived from evidence source in some evidentials in Paraguayan Guaraní. We are certainly open to the idea that such reductions are possible in some languages.[6] However, our goal here is to demonstrate that in some cases, the evidence source and the temporal relation between the evidence acquisition time and the prejacent reference time are independent variables and must both be semantically encoded. Moreover, we aim to show that the

[3] Morpheme glosses follow the Leipzig Glossing Rules where possible, with the following additions: CN 'common noun'; DECL 'declarative'; DIS 'distant'; EPIS 'epistemic'; EVID 'evidential'; EXP 'experiential'; IND 'indirect'; INF 'inferential'; NPST 'non-past'; PERC 'perceived; PN 'proper noun'; PREP 'preposition'; REC 'recent'; REPORT 'reportative'.

[4] An anonymous reviewer points out that what are treated as tenses in Smirnova's (2013) data are morphologically actually aspectual distinctions on perfect particles. Koev (2017), mindful of these morphological facts, posits two null tenses in evidential sentences, a present and a past. This is not directly relevant to our discussion, so we follow Smirnova's terminology for convenience.

[5] Smirnova (2013) (along with others such as Koev 2011) also points out that EAT must not follow the UT. As will be seen in Section 4, we adopt the same requirement.

[6] Related, but not the same, is the idea that evidentiality itself is reducible to relations between situations or spatiotemporal locations; see Faller (2004), Kalsang et al. (2013), among others.

evidential itself sometimes directly encodes the relevant temporal relation, independent of the tense contained in the prejacent.

The next section discusses evidentials whose temporal components are independent of the prejacent tense. That is, they encode a fixed temporal relation between EAT and EARLIEST(p), regardless of what tense the prejacent contains.

3. Temporal evidentials without tense

This section shows that evidentials exist that encode a fixed restriction on the temporal relation between the prejacent and EAT. We address two sets of evidentials. The first includes the English indirect evidentials *apparently* and *seem,* the Japanese indirect evidential *yooda*, and the St'át'imcets perceived evidence inferential *an'*. The second set contains the English epistemic modal *should* and the German epistemic modal *sollte*. We will show that the evidentials in the first group semantically encode the requirement that the earliest moment that the prejacent becomes true is at least as early as EAT, that is, EARLIEST(p) $\leq$ EAT. Meanwhile, the evidentials of the second group encode the opposite relation between the two times, that is, EAT $<$ EARLIEST(p). Importantly, these temporal restrictions do not vary depending on the tense in the prejacent. We call these evidentials 'temporal evidentials without tense', as they have fixed temporal components independent of tense.

We also address the question whether the temporal requirements of these two groups of evidentials can be reduced to a causal analysis based on Davis and Hara (2014). We show that this approach does not satisfactorily account for the distribution of the evidentials in either of our sets, and we argue that temporal requirements must be maintained in addition to causal ones.

3.1. Evidentials encoding EARLIEST(p) $\leq$ EAT

The elements discussed in this section have a variety of morpho-syntactic properties. *Apparently* is an adverb, *seem* a raising verb, and Japanese *yooda* is a sentence-final auxiliary. St'át'imcets *an'* is a second-position clitic, which attaches to the first element of the clause.

In addition to the requirement that there be indirect evidence, *apparently, seem, yooda* and *an'* encode the temporal relation EARLIEST(p) $\leq$ EAT. The presence of this temporal restriction can be seen in the following contrast (contexts from Matthewson and Truckenbrodt, 2018):

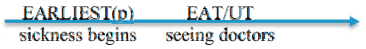
(3) a. **Apparently** she is very sick.

b. It **seems** that she is very sick.

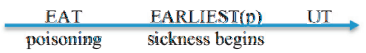
c. Kanojo-wa totemo taityoo-ga warui **yooda**.
she-TOP very health-NOM bad **IND.EVID**
'It seems that she is very sick.' (Japanese)

d. Qwenúxw=as-**an'** kw=s=Mary.
sick=SBJV-**PERC.EVID** DET=NMLZ=Mary
'Mary looks sick.' (St'át'imcets)

√ in Context A: Paula visits Mary in the hospital. Paula sees through the window of the hospital room that the doctors look worried. Paula says …



in Context B: Paula poisons Mary's food and leaves. Later, Paula says …



In Context A, Paula infers the truth of the prejacent from the evidence of the doctors looking worried, and EAT is the time at which Paula witnesses their worried look. The prejacent is that Mary is sick, so EARLIEST(p) is the moment that she got sick. Therefore, the temporal restriction EARLIEST(p) $\leq$ EAT is satisfied because the first moment of her sickness precedes EAT

when the doctors look worried. In Context B, in contrast, the evidence is the fact that Paula poisoned Mary's food and EAT is the time of the poisoning. Since EARLIEST(p), the first moment of Mary's sickness, follows EAT, the temporal requirement EARLIEST(p) $\leq$ EAT is violated. Thus, the contrast between the two contexts follows if the four evidentials encode EARLIEST(p) $\leq$ EAT.

The felicity of the following examples, which involve future prejacents, also supports the current claim. We provide two versions of the context for reasons of cultural appropriateness, but the temporal relations are identical.[7]

(4) (John comes to university in a formal suit only if he is going to attend a party that night. Today, you see John wearing a formal suit at the university at lunchtime. Just at that moment, John's friend calls you and asks where John will be tonight. You say:)

a. **Apparently** John **will** attend a party.

b. It **seems** that John **will** attend a party.

c. John-wa paatii-ni syussekisu-r**u** **yooda**.
John-TOP party-at attend-**NPST** **IND.EVID**
'It seems that John will attend a party.' (Japanese)

(Ned only comes to work wearing cowboy boots if he is going riding after work. Today, you see Ned come to work wearing cowboy boots. You say:)

d. Slheqw=ás=**an'=kelh** kw=s=Ned lh=gáp=as.
ride=3SBJV=**PERC.EVID=FUT** DET=NMLZ=Ned COMP=evening=3SBJV
'It looks like Ned is going to ride tonight.' (St'át'imcets)

As we will see below, assuming a modal analysis of the future tense, the prejacent of (4a), 'John will attend a party,' becomes true at the point when John's future attendance is one of the most natural consequences (e.g., when John decides to attend it). Therefore, EARLIEST(p) is the initial moment that John's attendance becomes the most natural future event. This moment precedes EAT because his attendance has been determined before he put on the suit, which is prior to when the speaker sees him wearing it. Thus, (4) satisfies the temporal requirement EARLIEST(p) $\leq$ EAT, and the contrast between (3) and (4) corroborates the presence of this restriction. (We provide timelines and further discussion of this type of example below.)[8]

One might argue against this temporal analysis, and propose attributing the contrast instead to the (un)availability of a *causal* relation between the prejacent and the evidence proposition. Specifically, Davis and Hara (2014) claim that *yooda* requires that the prejacent event causes the event described by the evidence proposition.[9] If the causal requirement explained everything, we would not have to place a temporal requirement on the semantics of the evidentials. However, we will present data for which the causal analysis cannot give an explanation.

The causal analysis does have initial plausibility, because for example the (in)felicity of (3a-d) can be derived from the claim that the prejacent event must cause the event in the evidence proposition. In Context A, the prejacent is that she is very sick and the evidence proposition is that the doctors look worried. The prejacent event (her being sick) causes the evidence proposition event (the doctors looking worried), so the causal requirement is satisfied. Meanwhile, in Context B, the prejacent event (her being sick) does not cause the evidence proposition event (the poisoning), so the causal requirement is violated. Thus, the causal requirement can capture the data in (4). Similarly, (4a-d) satisfy the causal requirement: the subject's party-attendance/ride causes him to wear the suit/boots.

Crucially, however, even in cases where the prejacent causes the evidence proposition, our four evidentials are infelicitous if the temporal restriction EARLIEST(p) $\leq$ EAT is not satisfied. Consider the following examples (again we provide two versions of the contexts):

[7] Several authors (Winans 2016 and Ippolito and Farkas 2019, among others) associate indirect evidentiality with the non-temporal use of the future. These arguments are not related to the current discussion because the future *will* in (4) is used as a temporal marker.

[8] For space reasons, we are glossing over some complexities involving Japanese, which has a past/non-past tense system and lacks a dedicated grammaticized future. See Ogihara (1996) for discussion.

[9] Takubo (2009) and Krawczyk (2012) make a similar argument: they argue that the prejacent of indirect evidentials must be the most plausible explanation for the evidence proposition.

(5) (John comes to university in a formal suit only if he is going to attend a party that night. You saw John wearing a formal suit at the university at lunchtime today. Tonight, John's friend calls you and asks where he is. You say:)

a. # **Apparently** John is at a party.

b. # It **seems** that John is at a party.

c. # John-wa patii-ni syussekisi-tei-ru **yooda**.
John-TOP party-at attend-PROG-NPST **IND.EVID**
'It seems that John is at a party.' (Japanese)

(Bucky comes to work in cowboy boots only if he is going riding after work. Today you saw him at work in his cowboy boots. This evening, Bucky's friend calls you and asks where Bucky is. You say:)

d. # Wá7=as-**an'** slheqw kw=s=Bucky.
IPFV=3SBJV-**PERC.EVID** ride DET=NMLZ=Bucky
'It looks like Bucky is riding.' (St'át'imcets)

Examples (5a-d) satisfy the requirement that the prejacent cause the evidence proposition: John's attendance/Bucky's ride causes them to wear a suit/boots earlier in the day. Nevertheless, the evidentials are all infelicitous, because they violate our temporal restriction. EAT is the time the speaker witnessed John/Bucky wearing the relevant piece of clothing, and EARLIEST(p) is the moment that John arrived at the party/Bucky began to ride: EAT precedes EARLIEST(p). This is inconsistent with the temporal restriction EARLIEST(p) $\leq$ EAT.[10]

One might argue against the claim that the causal requirement fails to capture the infelicity of (5), by saying that these are infelicitous because the supposed effect of the causation temporally precedes the postulated cause, which violates a necessary condition on causation. It is often assumed that causes must temporally precede their effects (e.g., Menzies, 2017). According to that understanding, by definition it cannot be the case that in (5a-c), John's future party-attendance (the prejacent) causes his suit-wearing (the evidence proposition). That would mean that (5a-d) do *not* involve causation, and the causation analysis correctly rules them out.

However, if (5) is ruled out because it does not involve traditional causation, then (4) should, contrary to fact, also be ruled out. This is because causation is traditionally a relationship between events rather than propositions. (4) differs from (5) in the temporal reference of the prejacent propositions, but the prejacent event is identical (the party-attendance/riding). Therefore, even in (4), the prejacent event time follows the event in the evidence proposition; if (5) cannot involve 'backwards' causation from the party/riding to the suit/boots, then (4) should be ruled out for the same reason. This suggests that the contrast between (4) and (5) should be explained in terms of the temporal restriction EARLIEST(p) $\leq$ EAT, rather than by causation.

Furthermore, the potential causation requirement relates the prejacent event to the event in the evidence proposition (the 'evidence event'), rather than to EAT. If our evidentials involved traditional 'forwards' causation and their temporal effect followed only from that, they would require the prejacent event time to precede the evidence event time: EARLIEST(p) $\leq$ EARLIEST($\tau(e_{ev})$). They should not tolerate a context with the temporal relation EARLIEST($\tau(e_{ev})$) < EARLIEST(p) $\leq$ EAT. However, this prediction is not borne out, as shown in (7).[11]

[10] With past-tensed prejacents also, the evidentials sound odd if EAT < EARLIEST(p). However, in English and Japanese, these cases sound slightly better than cases where the prejacent is present-tensed.

(i) (John comes to university in a formal suit only if he is going to attend a party that night. You saw John wearing a formal suit at the university at lunchtime yesterday. Today, John's friend calls you and asks where he was. You say:)

a. ? **Apparently** John was at a party.
b. ? It **seems** that John was at a party.
c. ?? John-wa paatii-ni syussekisi-tei-ta **yooda**.
John-TOP party-to attend-PROG-PST **IND.EVID**
'It seems that John was at a party.' (Japanese)

These subtle differences should be investigated in future work.

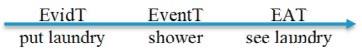
[11] It has not yet been possible to check this example, or (8) below, in St'át'imcets due to COVID-19.

(7) (John sometimes puts his school uniform in the laundry machine immediately after he comes home from school at 4pm, and whenever he puts his uniform in the laundry he always takes a shower right after that. Today, you come home late at night and find John's uniform is in the laundry machine. You say:)

a. **Apparently** John took a shower.

b. It **seems** that John took a shower.

c. John-wa syawaa-o abi-ta **yooda**.
John-TOP shower-ACC take-PST **IND.EVID**
'It seems that John took a shower.' (Japanese)



Here, the evidence is John's uniform in the laundry machine. EARLIEST(p) (the moment John began to take a shower) follows EARLIEST($\tau(e_{ev})$) (the moment John put his uniform in the machine). The felicity of the evidentials shows that their behaviour is not captured by a traditional causation account. Note that in (7), our temporal restriction EARLIEST(p) $\leq$ EAT is satisfied because EAT (the time the speaker sees John's uniform in the machine) follows the moment that John began to take a shower.

Finally, the causation analysis wrongly rules out examples such as (8):

(8) (When you come home, your husband phones you and asks if your daughter Mary is home. You hear Mary singing from her room. You say to your husband:)

a. **Apparently** she is home.

b. It **seems** that she is home.

c. Kanojo-wa ie-ni iru **yooda**.
she-TOP house-in be **IND.EVID**.
'It seems that she is home.' (Japanese; Hirayama (2020b:346))

Here, the prejacent event (Mary being home) is not the cause of the evidence (Mary's singing). This shows that the relevant inference relation in these evidentials is not causation. In contrast, our temporal proposal that EARLIEST(p) $\leq$ EAT explains all the data so far.

It is important to note, however, that we do not argue that these evidentials encode *only* the temporal requirement. As Menéndez-Benito and Moulton (2021) point out, there are also data (for example involving *seem*) which the temporal analysis alone cannot account for; they argue for a causality requirement in addition. Hirayama (2020b) proposes that the evidentials discussed here encode a counterfactual requirement that can be an alternative to the causal one, in addition to the temporal requirement.[12]

3.2. *Evidentials encoding EAT < EARLIEST(p)*

This section investigates evidentials with a temporal restriction that is opposite to the one seen above. Specifically, we claim that the epistemic modals *should* and German *sollte* encode EAT < EARLIEST(p).[13] In terms of evidential source, we assume that both these modals encode inferential evidence; see Matthewson and Truckenbrodt (2018) for argumentation.

In (9), EARLIEST(p) precedes EAT (the moment she got sick precedes the speaker's witnessing of the doctor's worried look), and *should* and *sollte* are infelicitous. In the felicitous (10), EAT precedes EARLIEST(p) (the poisoning precedes the moment she got sick). This contrast follows if *should* and *sollte* encode the temporal requirement EAT < EARLIEST(p).

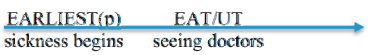
[12] An anonymous reviewer judges future-tensed prejacents in the B scenario in (3) (i.e., *Apparently, she will be sick* and *It seems that she will be sick*) to be unacceptable, and points out that our temporal requirement does not rule out these examples given our analysis of the future that will be developed in Section 4. The counterfactual requirement mentioned in this paragraph also causes the infelicity of those examples.

[13] *Sollte* is morphologically the Konjunktiv II-inflected form of the necessity modal *soll*, but following Matthewson and Truckenbrodt (2018), we treat these as two separate lexical items.

(9) (P visits M in the hospital. P sees through the window of the hospital room that the doctors look worried. P says:)

a. # She **should** be very sick.

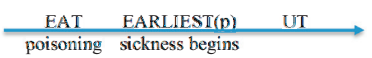
b. # Sie **sollte** sehr krank sein.
she sollte very sick be
'She should be very sick.'
(German; Matthewson and Truckenbrodt (2018:298-299))



(10) (P poisons M's food and leaves. Later P says:)

a. She **should** be very sick.

b. Sie **sollte** jetzt sehr krank sein.
she sollte now very sick be
'She should be very sick.'
(German; Matthewson and Truckenbrodt (2018:298-299))



As above, we should consider the possibility that the contrast between (9) and (10) is explicable in terms of the (un) availability of causation. The potential causal requirement for *should* and *sollte* would be the mirror image to what Davis and Hara (2014) propose for Japanese *yooda*; it would be that the evidence event causes the prejacent event.[14] In (10), the evidence event of the poisoning causes the prejacent sickness event, and the examples are good. In (9), the prejacent sickness event causes the doctors to look worried and the examples are bad.

However, as above, here also a causal approach would not explain everything. First, *should* and *sollte* are still deviant when the evidence event causes the prejacent event (satisfying the potential causal condition), but EAT is located after EARLIEST(*p*) (violating our temporal condition):

(11) (If John is presenting at a conference, he always practices on his hotel terrace in the morning before his talk. You had no idea John was presenting at this conference, but you show up and see him presenting. Someone then asks you where John was this morning. You say:)

a. # He **should** have been on the terrace of his hotel.

b. ?? Er **sollte** auf der Terasse seines Hotel-s gewesen sein.
he **sollte** on the.DAT terrace his-GEN hotel-GEN been be
'He should have been on the terrace of his hotel.' (German)

The prejacent event is John being on the terrace, and the evidence event is John presenting his talk. Therefore, the causal requirement (that the evidence event cause the prejacent event) is satisfied. A causal analysis would incorrectly predict that the examples are felicitous. The infelicity is correctly predicted by our temporal requirement EAT < EARLIEST(*p*), since EAT (the time the speaker sees John presenting) follows the moment he went onto the terrace.

If the prejacent describes an event that follows EAT, *should* and *sollte* become felicitous, as we predict:

[14] Davis and Hara (2014) deal only with *yooda*. Here we discuss what the result would be if their analysis were extended to *should* and *sollte*.

(12) (If John is presenting at a conference, he always practices on his hotel terrace in the morning before his talk. Yesterday, you saw on the conference website that John would be presenting today. Today, in the morning, someone asks you where John is. You say:)

a. He **should** be on the terrace of his hotel.

b. Er **sollte** auf der Terasse seines Hotel-s sein.
he **sollte** on the.DAT terrace his-GEN hotel-GEN be
'He should be on the terrace of his hotel.' (German)

Like (11), (12) satisfies the causal requirement, since the evidence event (John's upcoming presentation) causes the prejacent event (John being on his terrace). In addition, (12) satisfies our temporal requirement, since EAT (the time the speaker sees the conference website) precedes the moment John went onto the terrace, fulfilling EAT < EARLIEST(p). The causal requirement alone cannot capture the contrast between (11) and (12).

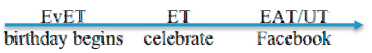
As discussed above, some authors hold that causes must precede their effects, so it might seem odd to claim that in the deviant (11), the cause (John's upcoming presentation) temporally follows the effect (his being on the terrace to practice). However, the same events as in (11) are involved in (12), but the latter is felicitous. If (11) were ruled out by a causal requirement on the basis that it is impossible for the presentation to cause the earlier being on the terrace, then the same reasoning should be applied to (12). Thus, a causal analysis cannot distinguish (11) from (12), but a temporal analysis can.

Furthermore, *should* and *sollte* can be deviant even if causation holds in a forwards temporal direction. If these evidentials encoded causation, they would require EARLIEST($\tau(e_{ev})$) < EARLIEST(p), as the evidence event is required to cause the prejacent one. If they also lacked our temporal restriction EAT < EARLIEST(p), they could be used in any case where EARLIEST($\tau(e_{ev})$) ≤ EARLIEST(p) holds. As (13) shows, this is not the case.[15]

(13) (You see John's Facebook profile and learn that yesterday was his birthday. You did not know this. John is very sociable and has many friends that would come to his birthday party if he invited them. You say:)

a. # John **should** have celebrated.

b. ?? John **sollte** gefeiert haben.
John **sollte** celebrated have
'John should have celebrated.' (German)



In this example, the evidence event (yesterday being John's birthday) causes John to celebrate, and EARLIEST($\tau(e_{ev})$) (the moment it became John's birthday) precedes his celebration. Therefore, traditional causation, with the cause preceding the effect, holds in this context. Nevertheless the sentences sound odd, since they defy the temporal restriction EAT < EARLIEST(p); EAT is when the speaker checks John's Facebook profile, which incorrectly follows EARLIEST(p) (the moment he begins to celebrate). The fact that even traditional causation is insufficient to explain the use of *should* and *sollte* underpins the presence of the proposed temporal restriction.

3.3. Summary

This section argued that *apparently, seem,* Japanese *yooda*, and St'át'imcets *an'* encode the temporal restriction EARLIEST(p) ≤ EAT, while *should* and German *sollte* encode the opposite relation, EAT < EARLIEST(p). This finding is novel because unlike other temporal evidentials in the literature, the temporal relations these evidentials encode between EAT and the prejacent are fixed, independent of the tense in the prejacent. We have claimed that these temporal restrictions cannot be reduced to causal requirements based on Davis and Hara (2014), and should be postulated independently in the lexical semantics of the evidentials.

In the next section we formalize the temporal restrictions.

[15] (13a,b) are acceptable under an irrelevant deontic and counterfactual reading, in which the speaker laments that John did not celebrate even though he should have.

4. Formal implementation

We assume that untensed propositions are functions from time intervals to the set of possible worlds where they are true:

(14) $[[p]]^g = \lambda t.\lambda w.\ p(t)(w)$

Following Partee (1973) among others, we assume that tenses are temporal pronouns with presuppositions that restrict the relation between them and the utterance time, as in (15) ((15c) is the St'át'imcets covert non-future tense, from Matthewson (2006:680)):[16]

(15) a. $[[\text{PRES}_1]]^g$ is only defined if g(1) is a contextually salient time and g(1) ○ UT.
If defined, $[[\text{PRES}_1]]^g$ = g(1).
b. $[[\text{PAST}_1]]^g$ is only defined if g(1) is a contextually salient time and g(1) < UT.
If defined, $[[\text{PAST}_1]]^g$ = g(1).
c. $[[\text{NON-FUT}_1]]^g$ is only defined if g(1) is a contextually salient time and g(1) ≤ UT.
If defined, $[[\text{NON-FUT}_1]]^g$ = g(1).

(16) defines the EARLIEST-operator. Applied to a tensed proposition *p* in a world *w,* EARLIEST picks out the unique moment *m* at which, in a world *w'* maximally similar to *w, p* is true and there are no times preceding *m* at which *p* is true.

(16) a. $\text{EARLIEST}_w(p)$ = the unique *m* such that $[[p]]^g(\{m\})(w') \wedge \forall t[[[p]](t)(w') \rightarrow m \leq t]$ for some *w'* maximally similar to *w*. (cf. Beaver and Condoravdi (2003))
b. $m \leq t$ iff $\forall m'[m' \in t \rightarrow m \leq m']$

This operator requires an element of type <*i*,*st*>, while tensed propositions are of type <*s*,*t*>. Therefore, we adopt an abstraction rule to combine them with the EARLIEST operator:

(17) $[[p]]^g$ can be shifted to $\lambda x.\ [[p]]^{g[n \rightarrow x]}$, which is defined only if the presupposition of $[[p]]^{g[n \rightarrow x]}$ is satisfied, where *x* is an arbitrary variable.

The application of this rule is illustrated in (18). The EARLIEST operator combines with this tensed (and abstracted) proposition and picks out the moment she starts to sing.

(18) a. $[[\textit{she 1 sings}]]^g = \lambda w.$ she sings at $g(1)$ in *w* (defined only if $g(1) \circ \text{UT}$).

b. ((17) applied)
$\lambda t.\ [[\textit{she 1 sings}]]^{g[1 \rightarrow t]}$
$= \lambda t.\lambda w.$ she sings at *t* in *w* (defined only if $t \circ \text{UT}$).

Following Hirayama (2020a), we propose the following definedness conditions for *apparently*, *seem*, *yooda*, *an'*, *should*, and *sollte*. In the formulae, *p, q,* and *t'* correspond to the prejacent, evidence proposition, and EAT, respectively. If the evidentials are not embedded, *t* is the utterance time.[17,18,19]

[16] Sharvit (2014) argues that the Japanese past tense is quantificational rather than pronominal, because Japanese past-tensed propositions cannot be embedded in *before*-clauses, which she derives from a clash between quantificational past and the EARLIEST operator. For space reasons, we assume the Japanese past is pronominal (see also Aonuki 2021), but see Hirayama (2020a) for a way to alter the semantics of EARLIEST to accommodate a quantificational past.

[17] We set embedded uses of these evidentials aside for future research. See, for example, Korotkova (2021) and references therein for discussion of embedded evidentials.

[18] We treat these definedness conditions as presuppositions for simplicity. The crucial point is that they are some type of not-at-issue content. For detailed discussion of the not-at-issueness of evidentials, see Murray (2014) and Korotkova (2020).

[19] An anonymous reviewer points out that our proposal as it stands runs into challenges once viewpoint aspects such as the imperfective or progressive are brought into the picture. In a sentence containing imperfective/progressive, EARLIEST(*p*) needs to output the start time of the eventuality, not the initial point of the reference time interval contributed by the aspect. The Appendix addresses this problem. For expository reasons, since we are not focusing on viewpoint aspects, we retain the overall simpler formulae given in the main text.

(19) Let q be the contextually salient proposition serving as evidence.

a. $[[\textit{apparently / seem / yooda / an'}]]^g(p)(t)(w)$ are defined only if $\exists t'$[the speaker learns q at $t' \wedge t' \leq t \wedge \text{EARLIEST}_w(p) \leq t'$].

b. $[[\textit{should / sollte}]]^g(p)(t)(w)$ are defined only if $\exists t'$[the speaker learns q at $t' \wedge t' \leq t \wedge t' < \text{EARLIEST}_w(p)$].

The conjunct $t' \leq t$ (EAT comes at least as early as the utterance time) is required because an utterance based on evidence cannot precede the acquisition of that evidence (Koev,2011; Smirnova, 2013). The third conjunct represents the evidentials' temporal restrictions.

4.1. On future-tensed prejacents

As shown in Section 3, evidentials with EARLIEST(p) ≤ EAT (*apparently, seem, yooda,* and *an'*) are compatible with the prejacent event being located in the future. This might sound contradictory, because future events necessarily follow EAT. Crucially, however, the prejacent event can only be in the future if the prejacent contains future marking. Here we demonstrate that these facts can be accommodated by assuming a modal analysis of future markers.

Recall that with *apparently, seem, yooda* and *an'* it is felicitous for the prejacent to be 'John will be at a party/Ned will go for a ride' (see (4)). Here, EAT is when the speaker sees the subject wearing a suit/boots, which precedes the moment John arrives at the party or Ned starts to ride. If EARLIEST(p) referred to the initial moment of the event, the restriction EARLIEST(p) ≤ EAT would be violated.

However, EARLIEST(p) refers to the initial moment of the prejacent's temporal denotation, not of the event. The temporal restriction is satisfied by assuming a modal analysis of future operators roughly as in (20):[20,21,22,23]

(20) $[[\text{FUTURE}]]^g = \lambda p.\lambda t.\lambda w.\ \forall w'[w' \in \max_{g(w)}(\cap f(t)(w)) \rightarrow \exists t'[t < t' \wedge p(t')(w')]]$

This future modal contains two contextually salient parameters: the modal base f and ordering source g (Kratzer,1981). We assume for concreteness that the modal base is circumstantial (Abusch,2012); it takes a time t and a world w and generates a set of propositions that capture relevant facts at t and w. The ordering source is stereotypical and thus describes normal courses of events; it assigns to a world a set of propositions that are normally true in that world. FUTURE(p) is true at t in w if and only if p is true at a time following t in all worlds that are contained in $\cap f(t)(w)$, (i.e., that conform to the facts at t in w), and that are best-ranked (making the largest number of propositions in $g(w)$ true). The future truth of p in all worlds satisfying these two conditions means that p is one of the most natural future consequences given relevant facts at t in w. In other words, the future proposition becomes true at the time t at which it becomes true that John's attendance happens in all worlds compatible with the relevant facts at t that are compatible with stereotypical expectations.

With this in place, we derive the following:

(21) $[[\textit{John will be at a party}]]^g = \lambda t.\lambda w.\ \forall w'[w' \in \max_{g(w)}(\cap f(t)(w)) \rightarrow \exists t'[t < t' \wedge$ John is at a party at t' in $w']]$.

This is true at t in w if and only if John being at a party at a time t' following t is one of the most natural consequences given relevant facts at t in w.

Crucially, EARLIEST(p) precedes EAT in (4), because EARLIEST(p) is the initial moment that John's future attendance becomes one of the most natural consequences given the facts at that moment. As John wears a suit only if he is attending a party, John's attendance must already naturally follow from the facts when John put on his suit. That time precedes EAT (when the speaker sees John wearing his suit), satisfying EARLIEST(p) ≤ EAT. Thus, although the event time (John's being at a party) follows EAT, the initial moment that the modalized prejacent becomes true precedes it. Fig. 1 schematizes this.

[20] Setting aside irrelevant differences and details, this denotation applies to future-marking in all the languages under discussion; see Rullmann et al. (2008) for the St'át'imcets future modal *kelh*.

[21] There are of course other analyses of the future; for example, Cariani and Santorio (2017) propose that English *will* is a modal, but not a quantifier over worlds. We set these issues aside here, but our proposals about evidential-temporal interactions should be replicable within an alternative analysis of the future such as that of Cariani and Santorio.

[22] While the Japanese non-past tense is often treated simply as referring to some non-past time, some authors (e.g. Yoshimoto et al. (2000)) assume that it involves modality when it refers to a future event.

[23] The reason we do not adopt a non-modal prospective aspect is that the EARLIEST operator picks up the left boundary of the prejacent's temporal denotation, but a proposition with prospective aspect such as $\lambda t.\ \lambda w.\ \exists t'$ *John attend a party at* t' *in* w *and* $t' > t$ denotes a set of time intervals t that precede the event time t'. Therefore, it does not have a left boundary (that is, an earliest time) that the EARLIEST operator picks out, which results in undefinedness.

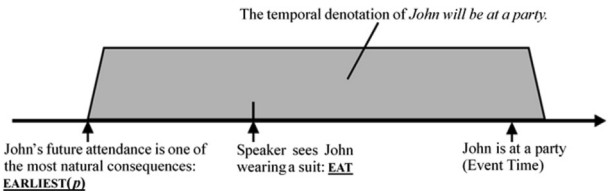


Fig. 1. Relevant temporalities in (4).

5. Non-temporal evidentials

This section addresses evidentials that do *not* restrict the temporal restriction between EAT and the prejacent's denotation. We discuss the English epistemic modal *must* (von Fintel and Gillies, 2010; Matthewson, 2015a), the St'át'imcets inferential evidential *k'a* (Matthewson et al., 2007; Rullmann et al., 2008), and the Gitksan inferential *ima* (Peterson, 2010; Matthewson, 2013). Comparison between temporal and non-temporal evidentials supports the claim that some evidentials hardwire a temporal ordering between EAT and EARLIEST(p).

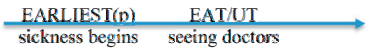
(22) shows that *must, k'a,* and *ima* are felicitous if EARLIEST(p) $\leq$ EAT (Context A), and they are also fine if EAT < EARLIEST(p) (Context B):

(22) a. Mary **must** be sick.

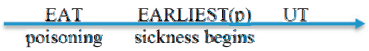
b. Qwenúxw=**k'a** kw=s=Mary.
sick=3SBJV=**INF** DET=NMLZ=Mary
'Mary must be sick.' (St'át'imcets)

c. Daxgyet=**ima**=hl ha-siipxw-s Mary.
strong=**EPIS**=CN INS-sick-PN Mary
'Mary must be sick.' (Gitksan)

√ in Context A: Paula visits Mary in the hospital. Paula sees through the window of the hospital room that the doctors look worried. Paula says …



√ in Context B: Paula poisons Mary's food and leaves. Later, Paula says …



These facts indicate that these evidentials put no restriction on the relation between EAT and EARLIEST(p), unlike the evidentials discussed in Section 3.

The variation between temporal and non-temporal evidentials is notable because it suggests that each evidential lexically specifies its own temporality, and the presence or absence of temporal requirements is not derivable from evidence type. For example, temporal *apparently* and non-temporal *k'a* both involve inference based on indirect evidence. So, we posit that temporal evidentials lexically constrain the relation between EAT and EARLIEST(p). The discussion of reportative evidentials in the next section supports this claim.

6. Extension to reportatives

This section deals with three reportative evidentials: Japanese *sooda* (a clause-final particle), St'át'imcets *ku7* (a second-position clitic; Matthewson et al., 2007), and Gitksan *gat* (a second-position clitic; Peterson, 2010). We show that *sooda* requires EARLIEST(p) $\leq$ EAT, while *ku7* and *gat* are non-temporal, encoding no restrictions on the relation between EAT and EARLIEST(p).

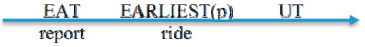
In (23), EAT is the time the speaker heard Florence's report, and it precedes EARLIEST(p), the moment Florence went riding. *Sooda* is infelicitous, but *ku7* and *ima* are fine.

(23) (Yesterday, Florence told me that she would go for a ride later in the day. Today, I say to another person:)

a. # Florence-wa kinoo doraibu-ni it-ta **sooda**.
Florence-TOP yesterday drive-for go-PST **REPORT** (Japanese)

b. Slhéqw=**ku7** kw=s=Florence inátcwas.
ride=**REPORT** DET=NMLZ=Florence yesterday (St'át'imcets)

c. Makxw=**g̲at** Florence ky'oots.
ride=**REPORT** Florence yesterday (Gitksan)
'Florence went riding yesterday (I heard).'



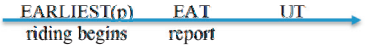
In contrast, all three reportatives are felicitous in (24). Here, EARLIEST(p) (the moment Florence went riding) precedes EAT (the time of the report).

(24) (Florence told you yesterday that she had gone for a ride earlier that day. A friend asks you what Florence did yesterday and you reply:)

a. Florence-wa kinoo doraibu-ni it-ta **sooda**.
Florence-TOP yesterday drive-for go-PST **REPORT** (Japanese)

b. Slhéqw=**ku7** kw=s=Florence i=nátcw=as.
ride=**REPORT** DET=NMLZ=Florence yesterday (St'át'imcets)

c. 'Nii t'aa=**g̲at** Florence a=hl gwidan ky'oots.
on sit=**REPORT** Florence PREP=CN horse yesterday (Gitksan)
'Florence went riding yesterday (I heard).'



These data suggest that *sooda* requires EARLIEST(p) to precede EAT, and *ku7* and *g̲at* are non-temporal. The fact that these reportative evidentials show variation in their temporal contributions corroborates the conjecture that some evidentials lexically specify temporal contributions, and that the temporal restrictions are not derivable from evidence type.

7. Conclusion

We have argued that some evidentials encode a fixed restriction on the relation between EAT and EARLIEST(p). This is notable because with many previous evidentials that have been argued to have temporality, their temporal contribution is to provide EAT, and the relation between EAT and the prejacent's temporal denotation varies according to a co-occurring tense.

We have seen two types of temporal evidentials without tense: *apparently, seem, yooda, an',* and *sooda* encode EARLIEST(p) $\leq$ EAT, while *should* and *sollte* encode EAT < EARLIEST(p). Our claim that these temporal restrictions are lexically hardwired is supported by comparison between the temporal evidentials and non-temporal ones (*must, k'a, ima, ku7,* and *g̲at*).

Given these results and following Hirayama (2020a), we propose that the variation among these evidentials reflects the presence of a parameter: [EAT-anterior/posterior]. [EAT-anterior] evidentials require EAT < EARLIEST(p), while [EAT-posterior] evidentials require EARLIEST(p) $\leq$ EAT.

Table 1 summarizes our results and presents the parametric typology of (non-)temporal evidentials. As shown by the N/A slot, one topic for future research is whether there are [EAT-anterior] reportative evidentials.

As seen in this table, the presence/absence of temporal restrictions cross-cuts and is independent of the evidence types encoded by the evidentials. This provides strong support for our claim that the temporal restrictions are hardwired into the lexical semantics. If, for example, *sooda*'s temporal restriction EARLIEST(p) $\leq$ EAT were derived from the requirement that the evidence be reportative, *ku7* and *g̲at,* which share the same evidence type, would wrongly be predicted to have the same temporal restriction.[24]

It is important before closing to clarify the relation of our proposals to prior work by Arregui et al. (2017). These authors argue (pace Smirnova, 2013) that the Bulgarian indirect evidential *-l-* makes no reference to EAT. For Arregui et al., what is

[24] An anonymous reviewer points out that EAT-posterior evidentials are restricted to the ones that require observed evidence or reportative evidence; what Willett (1988) calls evidentials of 'inference from reasoning' is excluded. We would like to leave this interesting observation as a topic of future research. Another anonymous reviewer hypothesizes that the type of evidential might be relevant, such that for example, epistemic modals pattern differently from the evidentials discussed by Koev (2017) and Bowler (2018), for principled reasons. This idea is also worth pursuing, although note that must differs from should and sollte in its temporal properties.

Table 1
The typology of (non-)temporal evidentials including reportatives.

	[EAT-anterior]	[EAT-posterior]	[−]
Indirect/Inferential	*should, sollte*	*apparently, seem, yooda, -an'*	*must, k'a, ima*
Reportative	N/A	*sooda*	*ku7, gat*

involved in *-l-*'s semantics is viewpoint aspects, rather than EAT. They also investigate two other languages, Mẽbengokre (Jê) and Matses, and conclude that we do not have to assume an 'evidential-specific' temporal paradigm involving EAT in addition to the utterance time, the reference time, and the event time. In their analysis, the prejacent's temporal denotation does not interact with EAT, and provides a fixed meaning whatever the tense is.

This sounds similar to our conclusion that some evidentials encode fixed temporal restrictions, and indeed, we fully agree with Arregui et al.'s (2017: 234) claim that 'temporal operators retain their usual interpretation in evidential contexts.' We have argued that in sentences with temporal evidentials without tense, the tense on the prejacent has its usual interpretation: it specifies the relation between the event time and the utterance time (or more precisely, the matrix evaluation time), rather than the relation between the event time and EAT. However, our findings differ from those of Arregui et al. in that our fixed temporal restrictions crucially make reference to EAT. While EAT does not play a role for Arregui et al. (2017), the discussion here indicates that we cannot completely wipe out EAT from evidentials' meaning, at least for the evidentials analyzed here.

A final implication we would like to point out is that the ordering between EAT and EARLIEST(p) is a potential semantic building block in the sense of von Fintel and Matthewson (2008). They claim that semantic universals will likely not be found at the level of familiar categories such as 'perfective', 'accomplishment,' etc. Instead, they hypothesize that there are smaller universal building blocks, from which the larger categories are composed. Following Hale (1986), Matthewson (2019) argues that for a given semantic piece to constitute a building block, it need not be overtly morphologically marked, but it should be detected across different parts of the grammar (that is, it should not be tied to particular syntactic projections).

The ordering between EAT and EARLIEST(p) clearly fits the first criterion, since the ordering is only one of the semantic contributions of evidentials: they also encode evidence-type specifications. The ordering is independent of other aspects of evidentials' semantics (recall that *sooda, ku7* and *gat* are all reportatives but only *sooda* encodes EARLIEST(p) $\leq$ EAT).

The temporal ordering also fulfills the second criterion, as it is found in various parts of the syntactic tree. *Apparently* is an adverb; *seem* is a raising verb; *should* and *sollte* are modal auxiliaries; *yooda* and *sooda* are sentence-final particles; and the St'át'imcets and Gitksan evidentials are second-position clitics. The fact that the ordering between EAT and EARLIEST(p) recurs in different parts of the grammar supports the idea that it could be one of the universal semantic building blocks.

Declaration of competing interest

The authors have no conflicts of interest.

Appendix. On the problem of the viewpoint aspects

As we noted in footnote 20, the EARLIEST operator formulated in (16) yields an undesired result when combined with imperfective/progressive aspects. It is commonly assumed that these aspects require the reference time to be contained within the event time. Therefore, the EARLIEST operator in (16), whose output is the initial moment of the reference time, cannot refer to the initial moment of the event described by the prejacent. This is not what the EARLIEST operator is intended to do.

However, we can make reference to the initial moment of the event time if the EARLIEST operator is relativized to events as in (i), and we adopt a denotation for the progressive as in (ii) ($\tau(e)$ represents the runtime of the event e):

(i) $\text{EARLIEST}_w(p)$ = the unique moment m such that $\exists e[p(w')(e) \wedge m \in \tau(e) \wedge \forall t'[t' \in \tau(e) \rightarrow m \leq t']]$ for some w' maximally similar to w.

(ii) $[[\text{PROG}]] = \lambda P_{<i,<s,<v,t>>>}.\lambda t_i.\lambda w_s.\lambda e_v.\ P(t)(w)(e) = 1 \wedge t \subset \tau(e)$.

In addition, we assume the following structure for *Apparently, Alexis is singing*, where tense provides a contextually salient time that overlaps with UT (as in (15a)).

(iii)[APPARENTLY [$_{TP}$ TENSE$_{PRESENT}$ [$_{AspP}$ ASPECT$_{PROGRESSIVE}$ [$_{VP}$ *Alexis sing*]]]]

The composition proceeds as follows:

(iv)[[VP]] = $\lambda t_i.\lambda w_s.\lambda e_v$. Alexis sings in e at t in w
[[AspP]] = $\lambda t_i.\lambda w_s.\lambda e_v$. Alexis sings in e at t in $w \wedge t \subset \tau(e)$
[[TP]] = $\lambda w_s.\lambda e_v$. Alexis sings in e at g(1) in $w \wedge$ g(1) $\subset \tau(e)$. (g(1) ○ UT)

The EARLIEST operator combines with TP and yields the following (note that in this framework, we no longer need the abstraction rule in (17)):

(v) EARLIEST_w([[TP]]) = the unique moment m such that $\exists e$[Alexis sings in e at g(1) in w' $\wedge$ g(1) $\subset \tau(e) \wedge m \in \tau(e) \wedge \forall t'[t' \in \tau(e) \rightarrow m \leq t']$] for some w' maximally similar to w. (g(1) ○ UT)

In this formula, m is the initial moment of the entire event e, but not the initial moment of g(1), which is contained within $\tau(e)$. Thus the modified version of the EARLIEST operator successfully picks out the initial moment of the eventuality.

As for the perfect aspect, the EARLIEST operator has to pick out the initial moment of the resultant state, rather than the initial moment of the event time. To do this, we assume a denotation for perfects as in (vi).

(vi)[[PERF]] = $\lambda P_{<i,<s,<v,t>>>}.\lambda t_i.\lambda w_s.\lambda e_v$. $\exists t',e'[P(t')(w)(e') = 1 \wedge \tau(e') < \tau(e) \wedge t \in \tau(e)]$.

This operator takes a predicate P and asserts that there is a time t' and an event e' that are located prior to the matrix evaluation time t. The event e in (vi) describes the resultant state. The structure and composition of *Alexis has sung* are provided in (vii).

(vii)[$_{\text{TP}}$ $\text{TENSE}_{\text{PRESENT}}$ [$_{\text{AspP}}$ $\text{ASPECT}_{\text{PERFECT}}$ [$_{\text{VP}}$ *Alexis sing*]]]
[[AspP]] = $\lambda t_i.\lambda w_s.\lambda e_v$. $\exists t',e'$[Alexis sings in e' at t' in $w' \wedge \tau(e') < \tau(e) \wedge t \in \tau(e)$].
[[TP]] = $\lambda w_s.\lambda e_v$. $\exists t',e'$[Alexis sings in e' at t' in $w' \wedge \tau(e') < \tau(e) \wedge$ g(1) $\in \tau(e)$]. (g(1) ○ UT)

The EARLIEST operator, when combined with this TP, yields the following:

(viii) EARLIEST_w([[TP]]) = the unique moment m such that $\exists e[\ \exists t',e'$[Alexis sings in e' at t' in $w' \wedge \tau(e') < \tau(e) \wedge$ g(1) $\in \tau(e)] \wedge m \in \tau(e) \wedge \forall t'[t' \in \tau(e) \rightarrow m \leq t']$] for some w' maximally similar to w. (g(1) ○ UT)

In (viii), m corresponds to the initial moment of $\tau(e)$, which represents the runtime of the resultant state.

Finally, since the EARLIEST operator is relativized to events, we need to alter the denotation of the future tense accordingly. We assume the following event-related semantics for a modalized future tense:

(ix)a. [[FUTURE]] = $\lambda P_{<i,<s,<v,t>>>}.\lambda t_i.\lambda w_s.\lambda e_v$. $\forall w'[\max_{g(w)}(\cap f(e)) \rightarrow \exists t',e'[\ t < t' \rightarrow P(t')(w')(e')]]$
b. $\cap f(e)$ = {w: w is compatible with the facts available in e} (Hacquard (2006))

The most crucial difference is that the modal base f is relativized to events rather than worlds. The circumstantial modal base f takes an event e and generates a set of facts available in e (Hacquard,2006). The structure and composition of *John will attend a party* are given in the following:

(x) [$_{\text{TP}}$ $\text{TENSE}_{\text{PRESENT}}$ [$_{\text{ModP}}$ FUTURE [$_{\text{VP}}$ *John attend a party*]]]
[[ModP]] = $\lambda t_i.\lambda w_s.\lambda e_v$. $\forall w'[\max_{g(w)}(\cap f(e)) \rightarrow \exists t',e'[\ t < t' \rightarrow$ John attends a party in e' at t' in $w']]$.
[[TP]] = $\lambda w_s.\lambda e_v$. $\forall w'[\max_{g(w)}(\cap f(e)) \rightarrow \exists t',e'[$ g(1) $< t' \rightarrow$ John attends a party in e' at t' in $w']]$. (g(1) ○ UT)

Thus, *John will attend a party* is true in e in w iff John attends a party at a time following the utterance time in all worlds (i) that conform to the facts in e and (ii) that are best-ranked in terms of what is stereotypical in w. In other words, *John will attend a party* becomes true in an event e iff John's future attendance is one of the most natural consequences in e, just as in (21). The EARLIEST operator picks out the initial moment of such an event. Thus, we can accommodate examples with progressives and perfects by modifying the denotation of the EARLIEST operator.

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