An excellent addition to the thriving new genre of handbooks and survey articles – distinguishing itself by its emphasis on combining insights from philosophy and linguistics on issues of interest to all scholars of natural language meaning. Ambitious in conception, Altshuler has shepherded the enterprise to an impressive final product. Contributors include researchers from both fields, topics include some classic and some emerging areas of investigation. The combination makes for a compelling volume.
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This collection offers a comprehensive and authoritative survey of where semantics and pragmatics stand after a half century of transformative collaboration between philosophers and linguists. Leading researchers make a powerful case for continued partnership, highlighting questions where progress requires integrating the two perspectives. The volume is an indispensable resource for linguists and philosophers who aspire to deepen our understanding of meaning and communication.
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Solicited with editorial insight and expertise, the chapters revisit foundational commitments, set classical questions in a new light, and raise new big questions, sometimes sparked by cross-linguistic work. Written in a careful and accessible way, this book is bound to inspire a new dialog between linguists and philosophers.
Anna Szabolcsi, *Professor of Linguistics, New York University*

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Linguistics Meets Philosophy

Edited by Daniel Altshuler

8   Evidentiality: Unifying Nominal and Propositional Domains

Diti Bhadra

8.0   Questions and Answers

(1)   Why do you think both linguists and philosophers find evidentiality interesting?

The phenomenon of evidentiality has been a prime topic of interest for linguists and philosophers because it lies at the intersection of the cognitive processes of human reasoning, perception, acquisition of beliefs, and the causal connections between these domains.* Evidentiality is also among one of the most well-studied phenomena empirically, with an extensive body of work describing diverse crosslinguistic patterns. Almost overwhelmingly, this body of work has been about propositional evidentiality, i.e. evidentials that have scope over a proposition and provide information about how that proposition came to be available to the agent. In this chapter, my goal is to also bring the sparsely studied phenonemon of non-propositional evidentiality into the fold and provide a unified approach to both domains. While propositional evidentials signal a particular flavor of evidence (sensory/perceptual, inference, report) towards propositional content, non-propositional evidentials scope over subsentential constituents (overwhelmingly noun phrases), and are fused with the determiner/demonstrative systems or with nominal tense markers. The juxtaposition of these subtypes of evidentiality makes the discussion even more interesting to researchers studying the mechanisms underlying the acquisition of knowledge and beliefs. I want to also highlight that a phenomenon like evidentiality is of high significance in the modern era of disinformation in written media, proliferation of fake news, and manipulation of our communication systems to delegitimize objective truth. We have seen in the very recent past legal and political debates over hearsay vs. direct evidence (late 2019, early 2020), claims taken out of context in political discourse (where the context contained evidential information), etc. Formal studies of

243

evidentiality can thus not only intrigue linguists and philosphers interested in theoretical and cognitive architecture, but also find direct applications in computational linguistic research aiming to fight disinformation, as well as socio-linguistic analyses of today's social and political world.

(2)   What recent developments in linguistics and philosophy do you think are most exciting in thinking about evidentiality?

There has been a great deal of exciting work in theoretical, empirical, and experimental approaches to evidentiality. However, the interaction between evidentiality and two other prolific corners of the grammar have revealed astounding underlying connections – between evidentiality and temporal and aspectual categories, and between evidentiality and speech acts. The latter work has revealed that the internal semantics of evidentials are sensitive to the grammatical point of view encoded by particular speech acts (Murray 2010; Bhadra 2020), while the former body of work has demonstrated how the boundaries of events and their internal structure are interwoven with flavors of evidence (Chung 2007; Fleck 2007, among others). In this chapter, I demonstrate that there are cohesive parallels in how flavors of both propositional and non-propositional evidentiality interact with verbal and nominal tense and aspect.

(3)   What do you consider to be the key ingredients in adequately analyzing evidentiality?

The biggest challenge in this research area is to be able to accurately capture the interactions between evidentiality and tense and aspect in compositional terms. This challenge is especially magnified by the attempt at unification of propositional and nominal evidentiality, since in the latter subdomain we do not have the familiar interactions between evidence-bearing elements scoping over propositional objects. In this chapter, I use tools from modal logic to show that we can: (i) unify the subdomains of evidentiality using modal accessibility relations while also preserving important distinctions between them, (ii) use the same tools to compositionally capture the interaction between evidentials and (nominal and verbal) tense and aspect, and (iii) have the representation of an agent's certainty of belief be reflected in quantificational force.

(4)   What do you consider to be the outstanding questions pertaining to evidentiality?

I model nominal evidentiality in this chapter with the same tools as propositional evidentiality, but with divergent outcomes to capture their differences. However, two outstanding avenues of inquiry can be formulated: (i) can nominal evidentiality (i.e. evidence for a nominal) be reanalyzed as markers of evidence for statements about existence of the nominal instead? Taking this path would entail committing that all nominal evidentials are always covertly propositional

evidentials. I believe much more empirical work in the very understudied nominal tense and demonstrative/determiner systems are needed before we can begin to formulate diagnostics to tease apart these distinctions and consequently weigh conflating them; (ii) the ontological status of nominal tense is well debated in the literature, with recent work claiming that such a category does not exist. This chapter aims to analyze evidentiality in the nominal domain (which is intertwined with elements that have been argued to provide tense information) without taking an explicit stance on the theoretical debate surrounding the ontology of nominal tense itself. More detailed empirical work is needed to ascertain where the faultlines of such interspersed phenomena lie with respect to the predictions of the theory presented here.

8.1   Introduction

An evidential is a linguistic marker of *how* an agent came across a piece of information (Chafe & Nichols 1986; Aikhenvald 2004). This 'how' is termed as the *evidence* for the information, and natural languages allow a variety of manners of evidence-collection, leading to a range of evidentials. The issue of evidence for a proposition has been viewed in both linguistics and philosophy as a complex issue. The cognitive processes that are involved in qualifying the content of an agent's utterance with the source of the information are sensitive to several kinds of considerations: via **what mechanism** was the evidence collected (perceptual senses, inference from some observable consequences of an event, inference based on world knowledge, hearsay from a third party, hearsay from legends); **when** was the evidence made available to the agent temporally (when the event took place, or when the results were detected, or at a time distal/proximal to the time of the verbal report, and so on); how **reliable** is the source of the evidence (an agent may rank a third-party source over their own inference in a judge of trustworthiness). Consider the sentence below from Jarawara (Dixon 2004):

(1)   [[mee tabori   botee]-**mete-moneha**] otaaA   awa-**hamaro**
           3nsg   home:f old-FPnf-REPf   nsg.exc see-FPef
           ama-ke
           EXTENT-DECf
           'We were seeing this in the far past what was reported to be their old camp from far past.'

This sentence has three different evidentials on different elements, marking different flavors of evidence. In Jarawara, the evidentiality paradigm is fused with tense (much like in many grammaticalized evidentiality systems). The speaker uses a combination of a firsthand far past tense and a firsthand eyewitness evidential to denote that even though it was a while ago, they witnessed everything in person. In addition, the speaker uses a combination of the non-firsthand past tense and the reported evidential to mark the fact that

they have only third-party reports about the location being another group's old village (cf. Aikhenvald 2018). Such richness in marking evidence is not rare in the world's languages; evidentiality is a robust phenomenon spanning diverse language families.

Evidentials have been prime objects of interest for linguists and philosophers interested in the cognitive processes of human reasoning, perception, acquisition of beliefs, and the causal connections between these domains. Evidentiality is also among one of the most well-studied phenomena empirically, with an extensive body of work describing diverse crosslinguistic patterns. Almost overwhelmingly, this body of work has been about *propositional evidentiality*, i.e. evidentials that have scope over a proposition and provide information about how that proposition came to be available to the agent. In this chapter, my goal will be to provide an approach to evidentiality that incorporates both propositional as well as *non-propositional* evidentiality (henceforth, PE and NPE, respectively). The difference between the two types is located in their scope. Propositional evidentials have sentential scope (syntactically they can only appear with finite clauses; see Bhadra 2018), and signal the particular flavor of evidence (sensory, inference, report) for the propositional content. Non-propositional evidentials scope over subsentential constituents (overwhelmingly noun phrases; Aikhenvald 2004; Jacques 2018), and are fused with the determiner/demonstrative paradigms or with nominal tense markers. In (1) above, both these types of evidential marking are visible: the noun phrase is marked with REPORTATIVE evidential (fused with a far past tense),[1] while the proposition is marked with two DIRECT evidentials.

I chose to begin our discussion with an example from Jarawara for a few reasons. Firstly, NPE itself is attested in only a handful of languages (Jacques 2018). Secondly, Jarawara is one of the very few exceptions in the world that has lexicalized manifestations of both PE and NPE in the same language. Thirdly, it is known that overwhelmingly, most non-propositional evidential systems encode only *perceptual/sensory* evidence, i.e. that the referent denoted by the noun phrase the evidential scopes over became available to the agent through perception with (one of) the five senses (Aikhenvald 2018; Jacques 2018). Jarawara and Ilonggo (Daguman 2018) are the only two exceptions where sentential/propositional evidentials (REPORTATIVES and INFERENTIALS) show up on noun phrases like in (1) (but see note 16 below for an explanation of this difference).

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[1] Many languages have been reported to have tensed nominals that interact with evidentials in that the same markers often perform both functions. In this chapter, although I will discuss non-propositional evidentiality at length and its interactions with temporality to some extent, I will not go into a full-fledged analysis of nominal tense (see Nordlinger & Sadler 2004; Haude 2004; François 2005). In fact, the ontological status of nominal tense itself is contested (see Tonhauser 2006, 2007).

With the sparse body of work on NPE (when compared to PE), several questions have remained unanswered: why does such a fundamental divide exist among languages with PE and NPE? More succinctly, what is it about nominals that favors only sensory perception? What can a unified view of evidentiality look like to capture its interactions with temporal categories like tense, and spatial categories like demonstratives/determiners?

I will attempt to address some of these issues through the main question I will pursue: **what is at the semantic core of an evidential?** This work will provide the first comparative formal semantic account of perception of nominals and propositions that tackles these questions, and adds another dimension: temporality. I will argue that the semantic core of an evidential is *a spatio-temporal modal accessibility relation*.[2] By defining the properties of this accessibility relation with the tools familiar to us from modal logic (Hughes & Cresswell 1986, among others), I will directly encode the subtype of evidence in the semantics, explore how this semantic core interacts with the possible arguments of an evidential – propositions most often, individuals/ entities in some cases, as well as map the vital property of speaker certainty. Concretely, three distinct flavors of evidentiality will be argued to embody three distinct spatio-temporal modal accessibility relations:

 (i) at the semantic core of DIRECT (sensory) evidentials is a temporally sensitive *historical necessity* relation;
 (ii) in contrast, INFERENTIAL evidentials of pure reasoning have an *epistemic accessibility* relation;
(iii) while INFERENTIAL evidentials of results have a *combination* of the above two.

This analysis will also allow us to unify nominal and propositional systems in a principled way. This chapter is organized as follows. Section 8.2 lays out the empirical facts spanning propositional and non-propositional systems; Section 8.3 delves into the issue of perception and its cognitive underpinnings in natural language; Section 8.4 explores the domain of inferences of different types; Section 8.5 concludes.

8.2   The Empirical Landscape

Propositions in natural languages can be qualified with a whole range of evidentials (these categories go back to Willett 1988): sensory, inference from results of events versus inference of general reasoning, conjecture, hearsay with few or many degrees of separation. Many formal analyses of such propositional

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[2] This semantics is thus going to be different in a fundamental way from the spatio-temporal extensional (non-modal) semantics proposed in Faller (2004), Chung (2007), and Koev (2016).

evidentiality classes exist (Izvorski 1997; Garrett 2001; Faller 2002; Matthewson et al. 2007; Murray 2010; Bhadra 2017, 2020, among others). The majority of languages allow all or subsets of these flavors of PE to be manifested in grammatical morphemes (languages with grammaticalized evidentiality) or in adjectives, adverbials, particles, and certain verbs (languages without grammaticalized evidentiality). For example, two types of evidential flavors are shown below: in (2), the reporter is overtly specified, and thus the quotative evidential is used (in contrast to a reportative where the source need not be overt); (3) is felicitous when the speaker has not actually seen the rain but infers it from the wet ground they see, and thus uses the inferential evidential to qualify the proposition.

(2)   nayil   pi-ka   o-n-**tay**-yo   Korean quotative
        tomorrow   rain-SU   come-INDIC-QUOT-POL
        'They said it will rain tomorrow.'   (Sohn 2018: example 7d)

(3)   de.ring char.pa btang-**zhag**   Lhasa Tibetan inferential
        today   rain   fall-PERF.INFER
        'It has been raining today.'   (Delancey 2018: example 18)

   Non-propositional evidentiality, on the other hand, is mostly restricted to just the sensory/perceptual flavor of evidence; and even within that class, mostly just to visual perception. In addition, NPE is only instantiated in nominal tense paradigms, proximal/distal demonstratives, and some isolated cases of case marking (Jacques 2018). Jacques thus notes that PE and NPE form completely distinct systems in most languages.[3] For example, in Lillooet (Van Eijk 1997: 193, 195), two degrees of sensory evidential distinctions (visual versus nonvisual) are encoded by determiners. Below, (4) shows the visual sensory determiner, and (5) shows the nonvisual sensory determiner in Lillooet.

(4)   pun-lkan   **ti**=n-lk'wal'us=a
        find-1SG.A   DET:VIS=1SG.POSS-basket=EXIST
        'I found my basket.' (the referent is visible to the speaker at utterance time)

(5)   ctas   lakwta   llakwu   **kwu**=s?'alalam=a
        come   NON.VIS   there:NON.VIS   DET:NON.VIS.=grizzly=EXIST
        'There is a grizzly coming from there.' (speakers hears a grizzly but does not see it)

8.2.1   A Space-Time Continuum

In both PE and NPE systems, considerations of space and time play integral roles in the phenomenon of evidentiality. In PE languages where temporality is intertwined with evidentiality, three temporal relationships have been argued to play a crucial role in determining which tense/aspectual marking is reflected

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[3] Jarawara, Ilonggo (Aikhenvald 2018), and Nivacle (Fabre 2014) are the only known exceptions, but see note 16.

on the verb in the presence of what flavor of evidence. The three salient times are the time the event occurred, the time the evidence about the event was acquired by the agent, and the speech time. The relationships between the event time (ET) and the evidence acquisition time (EAT), between the ET and the speech time (ST), and between the EAT and the ST are the main determinants[4] of temporal marking, with Korean, Bulgarian, and Matses (Pano-Tacanan, Brazil and Peru) being the most well-studied of such systems (Chung 2007; Fleck 2007; Lee 2011; Smirnova 2012; Koev 2016). In these works, the temporal relations are hard-wired in the semantics, while differing flavors of evidentiality are implications of the semantics (though see Pancheva & Zubizarreta 2018 for an approach in the opposite direction for the tenseless language Paraguayan Guaraní). For example, in Bulgarian, shown in (6), the use of the morphological 'perfect of evidentiality' signals that the speaker has indirect evidence (Izvorski 1997: example 14); similarly in Hunza Burushaski (Dené-Caucasian, Pakistan), shown in (7), the speaker uses perfect aspect to signal an inference made from the results of an event (Bashir 2006):

(6)   Maria   celuna-**la**   Ivan
        Maria   kiss-PE   Ivan
        'Maria apparently kissed Ivan.'

(7)   khuulto giílt-ulo buT-an   tiS   gutshari-**lá**   qheér
        today   Gilgit-in great-INDEF wind blow-PERF.3S   disc
        'There was a storm in Gilgit today.' (concluded after seeing broken branches)

Many other languages embody this link between perfect aspect and inferential evidence apart from the ones mentioned above (including Turkic languages, Wakhi, Kalasha, Khowar, and Georgian, to name a few).

In contrast to evidentiality being marked in the aspectual system, many languages also house evidential contrasts in their tense paradigms. For example, Bashir (2006) reports that Malayalam, among a large number of other languages, uses the simple past as a signal of a directly witnessed event, shown below:

(8)   Raman-re   acchan   i   viTu   nirmmiccu
        Raman-GEN   father.NOM   this   house build.PST
        'Raman's father built this house.' (Speaker saw him building it).

Bringing both tense and aspect languages into the fold, we observe that the primary factors in temporal PE systems is to determine the nature of linear and overlapping relationships between ET, EAT, and ST, and consequently, the evidential overtones are deduced. Let us call this parameter the *temporal factor*.

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[4] Employing terminology and acronyms borrowed from Lee (2011) here.

The most direct NPE counterpart of the temporality in PE systems is in NPE systems where evidentiality is marked in the *nominal tense* paradigms. The crucial parameter in such paradigms is the **visibility** of the referent:

- when the nominal past tense is used, then the implication is that the referent is **not visible** to the speaker at utterance time;
- when the nominal present tense is used, then the implication is that the referent is **visible** to the speaker at utterance time.

This paradigm is present in Somali (Cushitic, Somalia; Lecarme 2008), Naviclé (Matacoan, Paraguay and Argentina; Gutiérrez 2016), and Nambikwara (Nambikwara, Brazil; Lowe 1999). Nominal tense in general is a much rarer phenomenon than NPE (Jacques 2018), making this list the most exhaustive one of the empirical facts currently known (and see note 1 for the contested status of nominal tense). What is crucial to note here is that it is the parameter of visibility of the nominal referent at speech time that underlies the choice of the tense marking. Let us call this parameter of visibility the *spatial* factor – i.e. the one that evaluates whether the referent is present in the visual space of the agent at the moment of utterance. For example, Lecarme (2008: example 21a) describes the following situation in Somali: both the speaker and the hearer know that the girl is present in the next room; by the use of past tense, the speaker signals that the girl is absent from the immediate visual context. Thus crucially, the referent is '*epistemically* present/visible but *evidentially* past/hidden/distant' (Lecarme 2008) and that is when the nominal past tense is used:

(9)   Inantaa-**dii**   uur   bay   leedahay
       girl-F.POSS2S-DEFF.PAST[NOM]   pregnancy   C/F.3FS   has.3FS
       Doctor to Mother: 'Your daughter is pregnant.'

Ivan and Özyildiz (2018) replicate this finding and further report that the *-dii* marker above is a part of pair of nominal tense markers (-KA and -KII)[5] in Somali which also function as definite determiners. The members of this pair are distinguished by the presence/absence of the same kind of visibility inference that Lecarme reports above in (9):

(10)   a. Shalay   waxa=an   firinayay   cadceed-**da**
            yesterday   FOC=1s   look.PAST   sun-KA
            'Yesterday I looked at the sun' ≈ **visible**
        b. Shalay   waxa=an   firinayay   cadceed-**dii**
            yesterday   FOC=1s   look.PAST   sun-KII
            'Yesterday I looked at the sun' ≈ **eclipsed**
                                              (Ivan & Özyildiz 2018: 27)

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[5] The *-dii* morpheme in (9) is an allomorph of -KII (Ivan & Özyildiz 2018).

The spatial factor is a robust one in evidentiality. There is a vast body of descriptive typological work that elaborates on how this concept of *distance* plays a role in the determination of evidential flavor (whether the agent was spatially proximal or distal to the salient objects/events being spoken about; see Friedman 2018 for a detailed list of works). Aikhenvald (2004) also observed that evidentials often develop from lexical expressions that are spatial deictics. In the formal literature, spatial relations have been encoded in the semantics of evidentials (Faller 2004; Chung 2007; Koev 2016)

The paradigmatic connection between visual perception and the known/ unknown is not limited to nominal tense NPE systems only. Some NPE languages that do not have nominal tense but mark evidentiality in their *determiners/demonstrative systems* privilege visibility over other sensory sources (Van Eijk 1997). For example, reconsider the Lillooet data in (4)– (5); Tung et al. (1964) show the same pattern for Tsou. We saw a difference in the morphological paradigm based on whether the speaker *saw* the referent at speech time or a previous time (the 'known' demonstrative *ti...a* is used) versus the speaker *heard*, *touched*, *tasted*, *smelt* the referent at speech time (the 'unknown' demonstrative *kwu...a* is used). In languages like Lillooet/Tsou then, exactly when the perception happened (i.e. speech time or sometime in the speaker's lifespan) is not a distinguishing factor in the choice of the demonstrative, but the type of perceptual sense used is.

Careful empirical work has revealed that there are several systems similar to Lillooet. For example, in the Shina languages (Dardic, Pakistan, Afghanistan, and India), particularly in Kohistani Shina and Tileli Shina, it is the visibility of the referent (as opposed to nonvisibility) that determines the choice between proximal and distal determiners (Schmidt 2000; Schmidt & Kohistani 2001), and **not** the interaction with speech time:

(11)   *aae/paár* proximal/deictic visual/visible to sp./addr.

        asá/pér distal/deictic   hearsay/not visible to sp./addr.

(12)   **pér**   bo   waá
        away   [invisible]   go.IMP EMPH
        'Go away!'

(13)   mõ **paár-aae**   váari   bój-m-as
        I   over.there (close, seen)   direction   go-IMPV-1SG
        'I am going over there (a short distance in the speaker's line of sight).'

However, visibility at speech time vs. nonspeech time can definitely be a cutoff point for lexical choices in *other* determiner/demonstrative subclasses within NPE systems. For example, Huijsmans et al. (2020) show that in ʔayʔaǰuθəm (a.k.a. Comox-Sliammon, Central Salish, British Columbia), the subset of determiners classified as 'CDE' (current direct evidence) require

that the speaker sees the referent at speech time, while the other subset of 'PDE' (previous direct evidence) determiners require that the referent is not visible at speech time:

ʔayʔaȷ̆uθəm Current Direct Evidence determiner ɬə:
Context: There's a woman on the beach and you see her now.

(14)   nɛ   **ɬə**=saɬtxʷ   ʔə=tə=q̓ʷɛt.
          be.there   F.SG.CDE.DET=woman   OBL=CDE.DET=beach
          'There's a woman on the beach.'

ʔayʔaȷ̆uθəm Previous Direct Evidence determiner šə:
Context: I'm at your house, telling you about the bear encounter I had this morning.

(15)   niʔ-uɬ   **šə**=miẋaɬ   ʔə=šə=ət^θ=ʔasq̓iyč
          be.there-PST PDE.DET=black.bear   OBL=PDE.DET=1SG.POSS=outside
          skʷiȷ̆uɬ
          morning
          'There was a bear in my yard this morning.' (Huijsmans et al. 2020: 11, 16)

Thus, within the determiner/demonstrative class of NPE languages, we have a divide between those that cut the pie along visibility/nonvisibility at any time (henceforth, Type I systems) vs. those that care about visibility/nonvisibility at speech time (henceforth, Type II systems). A striking similarity can be observed here between Type II determiner systems and the nominal tense paradigms above: in both types of languages, visibility at speech time is the crucial distinguishing factor in the choice of either using nominal past/present *tense* or a CDE/PDE *determiner*. An analysis which seeks to unify all these systems of evidentiality in the nominal domain has to represent these parallels in the semantics (see Figure 8.1). I model a semantics below which achieves this aim, and further unifies nominal evidentiality with its propositional counterparts using the same set of analytical tools.

We have seen the importance of both temporal and spatial deixis in the evaluation of evidence. The landscape of this interaction between the space-time continuum[6] and evidentials has been charted out well in PE systems. In this chapter, I will extend this landscape to include NPE systems. How can we represent the unifying factors across PE and NPE systems while preserving the differences?

In this comparative study of PE and NPE systems via the lens of the grammatical encoding of the space-time continuum, one of the major goals

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[6] I am using this term in a loose sense to refer to the joint involvement of temporality and spatiality in evidentiality, and not in the technical sense used in physics (i.e. where a space-time continuum is a mathematical model fusing three dimenions of space and one dimension of time into a single continuum; https://simple.wikipedia.org/wiki/Space-time).
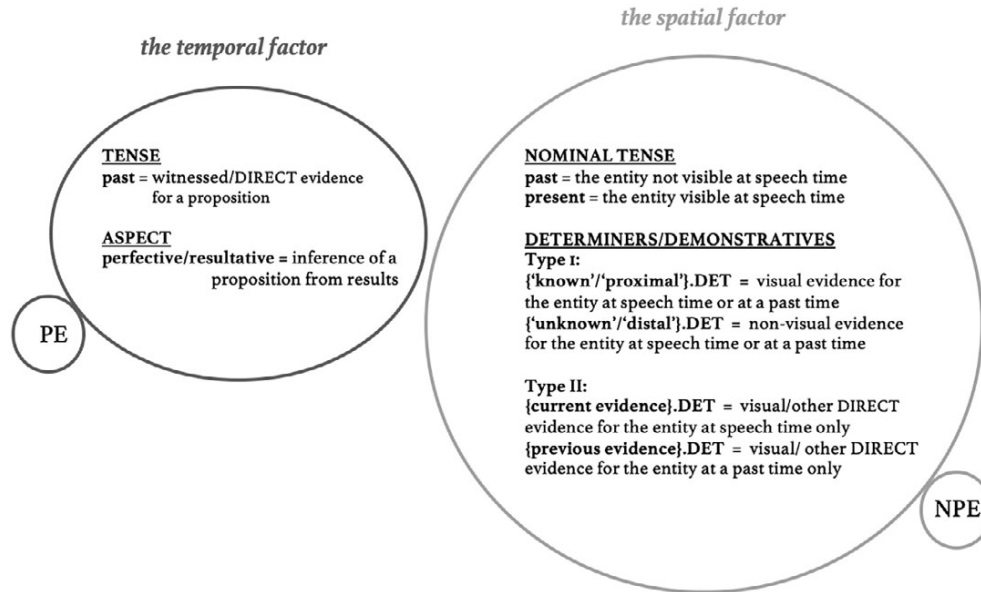
Figure 8.1 Goal: A unified account of propositional and non-propositional evidentiality (PE and NPE)

is to provide a unified understanding of what is at the heart of an evidential. I will propose that at the core of an evidential is a spatio-temporal modal accessibility relation. The general spirit of the proposal is in keeping with other spatio-temporal deixis-oriented work mentioned above, but with fundamental differences that will be pointed out as we proceed. The differing range of evidential meanings will be achieved via a range of accessibility relations, ranging from historical necessity (for perceptual evidence) to epistemic accessibility (for inference based on general reasoning) to the interaction between the two (for inference based on results).[7] These formal notions will be incorporated using the tools of modal logic.

I will also discuss two fundamental issues arising from the comparison between PE and NPE systems: (i) why do nominal evidentials overwhelmingly appear only in perceptual form, while propositional evidentials allow the full range? (ii) what is a shared component between perceptual evidence for a nominal and for a proposition? In addition, in the analysis proposed here, it will become clear that commitment of the speaker and their evaluation of the

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[7] I am not going to discuss REPORTATIVE evidentials here, mainly because temporality has not been attested to be a strict factor for those, since no matter when you received a report it will always be an indirect source of information, given that your own perceptual/inferential processes are not coming into play for the proposition in the scope of the REPORTATIVE evidential. See Faller (2002), AnderBois (2014), Bhadra (2020), among others, for the semantics of reportatives.

reliability of the evidence source is a core component of evidentials as well, which will be built in simultaneously into the spatio-temporal accessibility relations.

8.3   **Analysis: Perception**

Let us begin by exploring the notion of perceptual evidence. Perception is crucial to intelligent agents in forming a coherent mental picture of the physical space surrounding them, encompassing objects, events, individuals. Perception, like inductive reasoning and hearsay, underlies the formation of beliefs, and yet enjoys a more privileged status in terms of reliability given its very direct relationship with physical properties of the environment. However, the nature of perception is inherently complex, and accounting for how connections are built between sensing the *appearance* of an entity and *reality* has been long recognized as a problem for any theory of perceiving by philosophers and cognitive scientists alike (Musto & Konolige 1993). Perception has been argued to be *causal* in nature, such that perceiving an occurrence in the physical world leads us to acquire a logical belief of what the truth/reality looks like, unless our prior knowledge base already contains information that defeats this new acquisition (Grice & White 1961; Cox 1971; Musto & Konolige 1993).

The main idea I want to underscore in this discussion is that perception has an epistemic component. The philosopher Dretske in his pioneering work (Dretske 1969, 1981, 1990) on the philosophy of perception (also see Jackendoff 1983 for the linguistic perspective, and Milner & Goodale 1995 for a neuropsychological one) has argued that what we are seeing at any given point of time is always evaluated against an existing body of knowledge he calls *proto-knowledge*.[8] The following (shortened) example from his work (Dretske 1969: 93) illuminates how our knowledge is incremented directly by visual perception, in a process Dretske calls *epistemic seeing*.

(16)   A: I have put some water on for tea; can you see whether it is boiling or not?
         B (perfunctorily): Yes, it is.
         A (suspiciously): Are you sure?

Dretske provides an extended discussion of how B cannot have known that the object on the stove is indeed water without visually experiencing it and confirming it himself. Thus, we have to be careful to not confuse the following: (i) *seeing that the water is boiling*, versus (ii) *seeing that something is boiling water* (Dretske 1969). In (i), the fact that it is water is asserted based on B's

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[8] We would not be very far amiss to argue that proto-knowledge is what modern day semanticists call an *epistemic modal base* (Kratzer 1991, 2002).

proto-knowledge (in this case taking A's assertion to be true), while the fact that it is boiling is accessed by B's own vision. In (ii), both the properties of the object being water and being currently boiling are confirmed by vision and thus added to the agent's knowledge. In formalizing a notion of perceptual evidence in this paper on evidentiality, I will apply these crucial insights. Mainly, what is termed as the process of perception is epistemic perception, such that the objects of perception are both evaluated against an agent's existent knowledge as well as help add to that knowledge new justified true beliefs causally formed via perception.

As stated above, my goal is to provide a view of evidentiality that encompasses both PE and NPE systems. In building the notion of epistemic perception just described, we will need tools that allow for "perceiving" both nominals as well as propositions (although intuitively propositions cannot be perceived; Lecarme 2008). How can we then build a cross-categorial model of epistemic perception that encodes both the spatio-temporal coordinates of physical reality and convey the (almost) absolute confidence that an agent places on the beliefs caused by perceptual processes?

The answer, I contend, lies in *historical modality* (Kamp 1979; Thomason 2002). A historical accessibility relation grants an agent a special kind of access:

(17)   **Historical accessibility relation** (Portner 2009: example 54)
         R is a historical accessibility relation iff for some time t, R = the relation which holds between two worlds w and w' iff w and w' are identical at all times up to and including t.

The guiding motivation behind historical modality is the need to model the asymmetry between a fixed past and an open future (based on a notion of "branching time," in which time is not a line but a tree with a fixed root (for past time) and many branching leaves (for possible future times) (Condoravdi 2001; Werner 2006)). A historical accessibility relation is a special modal relation whose role is to identify *historical alternatives* – i.e. given the world-time pair of evaluation $<w,t>$, its historical alternatives are worlds that are identical to w upto and including t, but are allowed to differ from w at times later than t. This accessibility relation can be pictorially represented as in Figure 8.2.

According to this model, at times later than t, the worlds start being different:

$$\text{(after } t) \; w \neq w' \neq w'' \neq w'''$$
$$\text{(before } t)'''w = {}''w = {}'w = w$$

Kaufmann et al. (2006) demonstrate this historical accessibility relation, denoted as $\approx$, is an equivalence relation in that it is reflexive, symmetric and
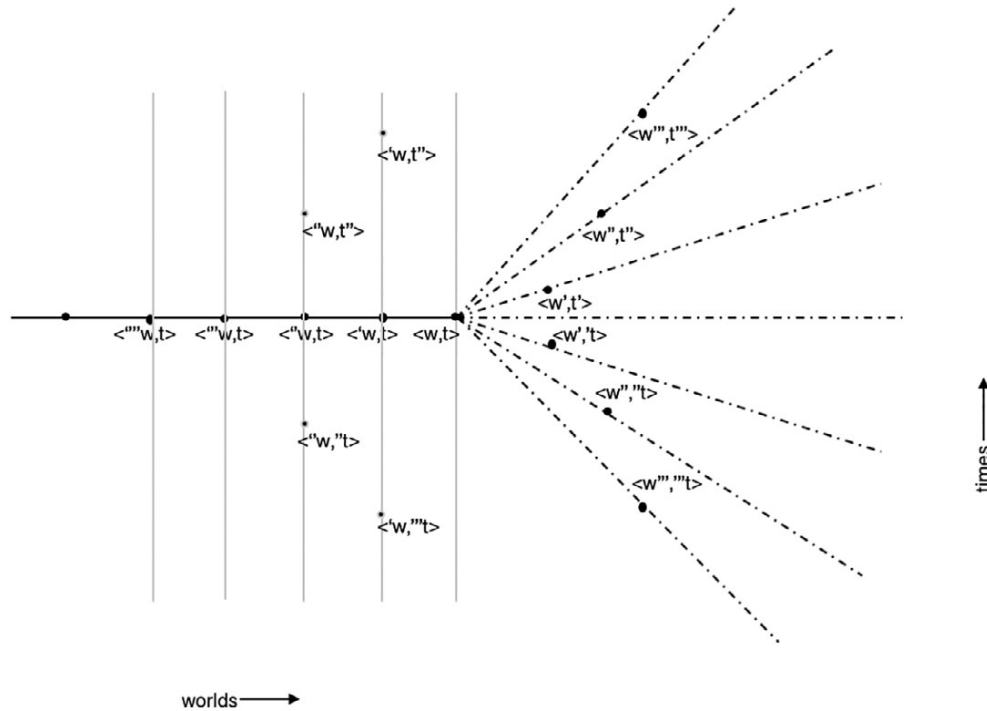
Figure 8.2 Historical alternatives

transitive. They formulate the crucial properties of the relation $\approx$ ('being a historical alternative to') as follows (Kaufmann et al. 2006: example 37):

(18)   Properties of $\approx$ (assuming $>$ and $<$ to be temporal precedence and succession relations, respectively (more on these operators below), and a truth assignment function V):

   a. $\approx$ is modal
   b. $\approx$ is an equivalence relation
   c. If $<w,t> \approx <w',t>$ and $t'<t$, then $<w,t'> \approx <w',t'>$
   d. If $<w,t> \approx <w',t>$, then for all atomic sentences p, $V_{<w,t>}(p) = V_{<w',t>}(p)$

   The last two clauses of the definition embody two important properties: (c) states that two worlds that are each other's historical alternatives at some time *t* have been historical alternatives at *all* times up to *t*, ensuring a hard-wired shared past. Accessibility of a world from the world of evaluation *w* at a given time is extended to all earlier times; (d) states that the truth assignment function assigns the same truth value to all atomic sentences that are evaluated at *w* and a historical alternative just like *w* – i.e. *w'*, given that they are identical worlds at a given time. The formulation in (18) then underlies the idea of **settledness** or **historical necessity**, because by design, truth at all historical alternatives results in necessity with respect to $\approx$. The past is thus incommutable in this design of metaphysical necessity (and the future

non-deterministically open), where an agent bases their certainty in their knowledge on the settledness arising out of universal access to all historical alternatives (denoted by $\Box_{\approx}$ by Kaufmann et al.).

Access to all prior (identical) worlds at a given time seems certainly necessary in modeling epistemic perception. Crucially however, we also need *temporal* accessibility, whereby we have access to prior times as well, given that we are exploring the fundamental involvement of temporality in evidentiality in a large number of languages. Kaufmann et al. (2006) add a temporal dimension to possible worlds, by introducing an ordered set $(T, <)$. $<$ (the *earlier than* relation) has the following properties (which are preserved by its inverse operator $>$ (the *later than* relation) as well (Kaufmann et al. 2006: example 31):

(19)　　Properties of temporal accessibility:
　　　　a. *irreflexivity*: not (t < t)
　　　　b. *transitivity*: if t < t′ and t′ < t″, then t < t″
　　　　c. *linearity*: t < t′ or t′ < t or t = t′

$>_{<w,t>}$ then gives us the set of all world-time pairs $<w,t'>$ that precede $<w,t>$ in time (given t > t′). The relationship holds in the opposite direction with $<_{<w,t>}$ as well, and additionally we have the sets $\leq_{<w,t>}$ and $\geq_{<w,t>}$ which include the current world-time pair $<w,t>$. We can quantify over these sets with the operators $\Diamond_{>/<}$ and $\Box_{>/<}$ Prior 1967, and evaluate $V_{<w,t>}$ $(\Diamond_{>}$ $p)$ as 1 iff $V_{<w,t>}$ (p) is 1 for some $<w,t'>$ *in* the > relation accessed from $<w,t>$, i.e. $>_{w,t}$.

Let us define perceptual evidence by combining both historical accessibility and temporal accessibility. I am going to use the symbol $\mathbb{K}$ to denote the combination of the operators $\Box_{\approx}\Diamond_{\geq}$ (the historical necessity relation and the *earlier than* temporal accessibility relation including the present time). The mnemonic R_{V-N} stands for the accessibility relation $R_{visual-nominal}$, since we are first going to define perceptual/visual evidence in an NPE system. Assuming that our universe is represented by (variables over) entities (e), worlds (w), times (t), and that $<w,t>$ is the current world-time pair of evaluation:

(20)　　Visual nominal: present
　　　　$R_{V-N-Pres(<wt>, <e, w', t'>)} =_{def} \{< e, w, t > \mid \exists < w', t' > \in \mathbb{K}_{<w,t>}$
　　　　SEE $(sp, e, w', t') \wedge t = t'\}$

The predicate SEE is true iff the speaker saw (in the pure sense of perceived via vision) the entity e at world w' and time t'. Since the *earlier than* temporal accessibility relation ($\Diamond_{\geq}$) grants access to the present time t and all times preceding t, the explicit restriction of equivalence between t and t' states that the seeing has be happening at the current time only. The output of this accessibility relation is a set of tuples with each member tuple consisting of

an entity, world, and time, and a specification that the speaker is seeing that entity currently as they are speaking, i.e. things/individuals visible to the speaker at speech time.[9] The morphological representation of this accessibility relation $R_{V-N-Pres}$ is the use of the nominal present in Somali, Naviclé, and Nambikwara.

In contrast, (21) has the same temporal accessibility relation that grants access to all of the times preceding t (including of course the historical alternatives as before), but with an explicit restriction that the seeing is not happening at speech time. Thus, the representation of the fact that at some point in all the world-time pairs before speech time, the speaker saw the referent is as follows:

(21)   Visual nominal: past
$R_{V-N-Past(<wt>,<e,w',t'>)} =_{def} \{<e,w,t> \mid \exists <w',t'> \in \mathbb{K}_{<w,t>}$
SEE $(sp,e,w',t') \wedge t \neq t'\}$

The output of this relation is a set of tuples with each tuple consisting of an entity, world, and time such that that entity was seen at that corresponding world and time. Crucially, the speech time cannot be any of these times. The nominal past tense shows up as the representation of this accessibility relation $R_{V-N-Past}$ in the same languages.

Now let us transition to propositional evidentiality while still remaining in the realm of perceptual/DIRECT evidence. The mnemonic R_{V-P} stands for the accessibility relation $R_{visual-proposition}$, since we are now going to define perceptual/visual evidence in a PE system. As soon as we are in the realm evidentials that scope over propositions, the validity of the propositions become salient. Assuming V is the valuation function in a frame in modal logic, and ψ is a proposition in the scope of a DIRECT evidential:

(22)   Visual propositional: past
$R_{V-P}(<w,t>,<w',t'>) =_{def} \{<w,t> \mid \forall <w',t'> \in \mathbb{K}_{<w,t>} \wedge$
$t \neq t', \ V_{<w',t'>}(\psi) = 1\}$

This semantics reflects the fact that a speaker considers a proposition available to her at some point in the past via her visual sense to be a *settled* matter. The validity of the proposition holds across all accessible historical alternatives. The output of the relation in (22) is the set of world-time pairs where ψ is true. Thus, ψ is being treated like a known fact, which is regarded as incommutable across (consistent) worlds and times. The flavor of evidence (i.e. visual in this case) is not encoded in the definition per se (as opposed to

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[9] Although the definitions in (20) and (21) are catered to visual evidence, they can be easily modified to reflect other sensory devices such as taste, smell, touch, and hearing. The predicate SEE can be replaced by any of these other predicates, with everything else in the definition remaining the same.

the nominal cases above); the universal quantification is a reflection of the measure of certainty.

This proposal can account for a large array of languages, where it has been observed that the simple past tense marking contributes a DIRECT evidential flavor or a **witnessed event**. For example, we saw above in (8) that Malayalam simple past carries such evidential overtones. Bashir (2006) provides similar data from many other languages, including Telugu, Tamil, Kannada, Marathi, and Wakhi, where the morphological past tense corresponds to the interpretation that the speaker saw/perceived the event happening themselves, and thus the proposition in the scope of the past tense is conveyed to have been learnt DIRECT-ly. The counterparts of the simple past tense, i.e. present or future tenses, are not attested as carrying evidential meanings in any of these PE languages (which is why Figure 8.1 does not include them either). The following examples are from Bashir (2006):[10]

(23)   viran inta viTaik   kaTT-**in**-an   (Tamil)
         Viran this house-ACC build-PAST-3SG
         'Viran built this house.' (personally witnessed or known as verified fact)

(24)   salim vaLl-a   nanna i   illu   kaTT-inc-**a**-Du   (Telugu)
         Salim ones-OBL father this house build-CS-PST-3SG
         'Salim's father built this house.' (personally witnessed)

(25)   majhy-ā bhāvā-nī   salīm-lā   patra lihi-**lā**   (Marathi)
         my-OBL   brother-AG salim-DAT letter write-PST
         'My brother wrote a letter to Salim' (personally witnessed)

The claim then is that all of these are historical necessity statements combined with *earlier than* temporal accessibility (as denoted by $\mathbb{K}$ above). Even for a language like Bulgarian, where INFERENTIAL evidence is marked in the aspectual domain, Koev (2016: 1) describes the simple past tense (assuming null tense marking) as encoding a witnessing of the event by the speaker.

It is important to clarify that while this proposal directly encodes evidential information for nominals, the modal component ensures that the speaker's judgment about the reliability of the information source is represented in the semantics as well. The settledness/historical necessity operator ensures that the speaker has access to all historical alternatives and there is no room for uncertainty about past and present (cf. Kaufmann et al. 2006). We want this kind of strength given the privileged status of direct perception in natural languages. Sentences with DIRECT evidentials cannot be followed with a

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[10] In my surveys with native speakers of these languages aimed at confirming Bashir's findings, I have found an age-based demographic divide. All older speakers attested to the evidential interpretations being present, while much younger (usually multilingual) speakers sometimes did not.

contradictory continuation, unlike sentences with REPORTATIVE evidentials (see (39) below).

The definition of visual evidence provided in (20) is partially inspired by Faller (2004)'s conception of a speaker's perceptual field, which she terms as *P-trace*, and defines it as follows (Faller 2004: example 37):

(26) $P\text{-}trace(sp) = \{< \text{t}, \text{l} > \mid \text{t} \subseteq \tau(sp) \land \text{PERCEIVE}(sp, t, l)\}$

The predicate PERCEIVE is true iff the speaker perceives *l* at *t*, where *t* is a time in the lifespan of the speaker. Faller uses this definition to map out the immediate physical space surrounding the speaker. This formulation is then used to provide a semantics for the Cuzco Quechua verbal marker -*sqa* which requires that the event in question was not directly perceived by the speaker, i.e. is not contained in the P-trace of the speaker. Two important points to note about (26) are as follows. Firstly, Faller is not modeling any *evidence* per se in (26), but is providing a way to track what the speaker can perceive at a given time. Crucially, the perceptual field is meant to be a subspace of the bigger physical space, including only elements that are an appropriate size for the speaker to perceive and ones they are actively attending to. Note that the arguments of the predicate include the *whole location* at a given time, and not any object/entity/individual within that location. My analysis of NPE in (20)/(21) does not encode a direct relationship with the entire location associated with an utterance. This is because the speaker perceives and evidentially qualifies a particular entity, and given that the speaker has successfully perceived this entity entails that the entity is in the perceptual field of the speaker at the time of utterance (i.e. is in some salient subset of the accessible perceptual field). Thus, we do not need to represent a location coordinate into the semantics per se.

In Faller (2004), the two spatio-temporal trace functions *P-trace* and *e-trace* (the mapping of the event in question) interact in the following manner:

(27) $\llbracket -sqa \rrbracket: \lambda \text{t}_R \ \lambda \text{P} \ \lambda \text{e}. \ \text{P}(e) \land \text{t}_R < now \land \neg \forall < t, l > [\text{t} \subseteq \text{t}_R \land < t, l >$
$\in e\text{-}trace \ (e) \rightarrow < t, l > \ \in P\text{-}trace \ (sp)]$

    a. where $e\text{-}trace(e) = \{< t, l > \mid \text{t} \subseteq \tau(\text{e}) \land \text{AT}(e, t, l)\}$
        AT(*e,t,l*) is true iff the event *e* takes place at time *t* at location *l*
        (cf. Condoravdi 2001)
    b. where t_R is the topic/reference time

The semantics of -*sqa* is thus an extensional statement about the spatio-temporal distance between the event and the speaker, and the lack of DIRECT/perceptual evidence is implied. There is no modal component in the formulation.[11] In fact,

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[11] Koev (2016) is another account of evidentiality in Bulgarian modeled along the lines of Faller (2004) that also argues for extensional spatio-temporal analysis over a modal one.

Faller explicitly rejects the following ideas with the following reasoning: (i) that *-sqa* is a true evidential, because it does not encode a relation between an agent and a proposition, and (ii) that *-sqa* is an epistemic modal, because there is no quantificational evaluation of the validity of a proposition with respect to the speaker's knowledge state.

I will make a departure from Faller (and many other major accounts of evidentiality) on a fundamental issue. Since we have seen that nominal evidentials exist, it is now too constricting to definitionally limit the phenomenon of evidentiality to just a relationship between an agent and a proposition. Nominal evidentiality as defined in (20) and (21) allows a relationship between an entity and the speaker at a world-time pair. The analysis of DIRECT evidence, and consequently of inferential evidence in Section 8.4, places the current proposal squarely in the ontological debate between evidentiality and epistemic modality (note that Von Fintel & Gillies 2010 observe that there are no attested epistemic modals that are not evidentials). Having argued for perception as being epistemic perception that provides access to historical alternatives (and inference in the next section on similar terms), the claim is that evidentials are modals (either historical or epistemic). The encoding of degrees of reliability of the source (which correlates directly with the degree of commitment the speaker has towards the argument of the evidential) of the evidence is a core component of evidentials, and the modal semantics allows us to successfully model that ingredient.

So far, we have explored NPE in languages where nominal tense marking functions as evidential markers. Recall that NPE is also found in systems without nominal tense, but with evidentiality marked in the demonstrative/ determiners paradigms: Type I systems such as Lillooet (see (4)–(5) above), Tsou (Tung et al. 1964), some Shina languages (see (11)–(13)), and Type II systems like ʔayʔajuθəm (see (14)–(15) above). In Type I systems, the core determining factor is *visibility* of the referent from the speaker's point of view. Quickly recapping, in Lillooet, for example, the determiner which marks a 'known' referent is used if the referent is either visible to the speaker at speech time and/or was visible to the speaker at any time in the past; in contrast, the determiner marking 'unknown' referents shows up when the referent is not visible to the speaker at speech time but is accessible by some other sensory device (auditory, olfactory, etc.) and/or was accessible by the same nonvisual means at a past time. So the choice of the determiner hinges on the seeing/ nonseeing difference and not on the current time/past time difference, which is essentially *the opposite* of the configuration we saw above for nominal tense systems. This distinction in accessing the same historical alternatives through different sensory devices can be pictorially represented as in Figure 8.3.

Now, can the proposal put forward for DIRECT evidence so far account for this opposite configuration? I suggest that it can, with essentially the same
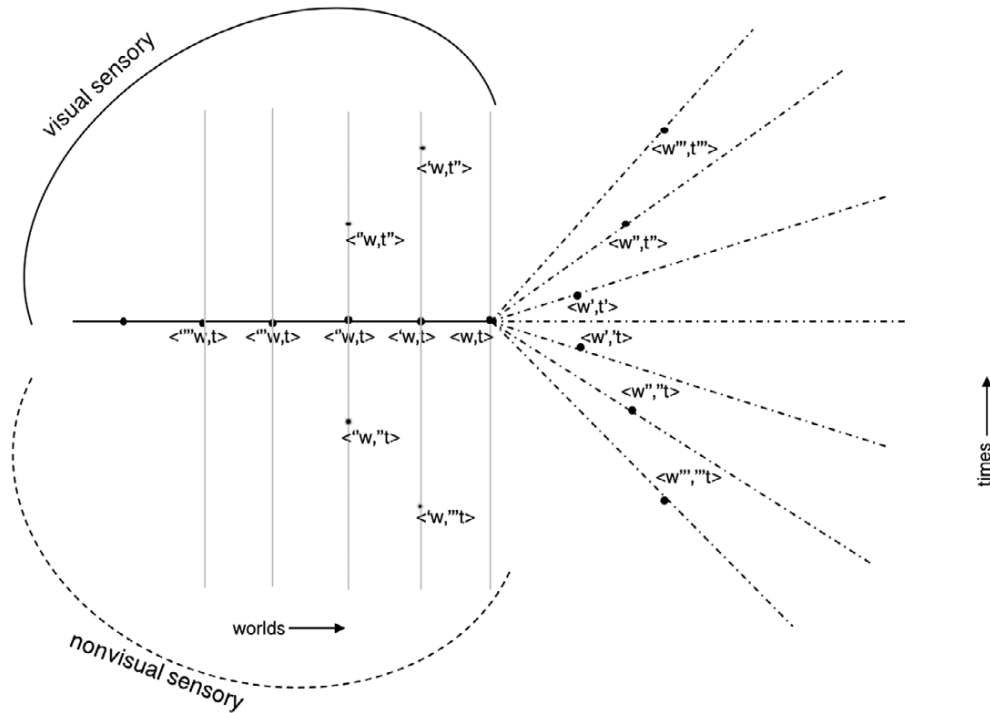
Figure 8.3 Visual/nonvisual access to historical alternatives

ingredients. With the same historical and temporal accessibility relation, now we can locate the difference in which sensory relationship holds between the speaker and an entity at some historically accessible world-time pair:[12]

(28) $R_{visual-dem(<wt>,<e,w',t'>)} =_{def} \{< e, w, t > \mid \exists < w', t' > \in \mathbb{K}_{<w,t>}$
         SEE $(sp, e, w', t')\}$

(29) $R_{non-visual-dem(<wt>,<e,w',t'>)} =_{def} \{< e, w, t > \mid \exists < w', t' > \in \mathbb{K}_{<w,t>}$
         SMELL/HEAR/TASTE/TOUCH $(sp, e, w', t')\}$

Note that we do not need an explicit temporal restriction stating whether the time satisfying the existential quantification is the speech time or not, since that consideration is not a factor in the Lillooet/Tsou/Shina type of demonstrative systems, i.e. the Type I dem/det languages. In these languages then, the determiner/demonstrative associated with 'known' is the lexical manifestation of the relation $R_{visual-demonstrative}$ ($R_{visual-dem}$) in (28), while the determiner/ demonstrative associated with 'unknown' is the lexical counterpart of the $R_{non-visual-demonstrative}$ relation ($R_{non-visual-dem}$) in (29). The visual/nonvisual

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[12] As mentioned in note 7, for nonvisual cases, we would have to do the same thing for nominal tense systems.

distinction is a very integral one in the empirical landscape – Aikhenvald (2018) reports that no spoken languages have special evidentials to cover just smell or taste or touch individually. These sensory devices are often covered by a single lexical item, which is usually a nonvisual sensory evidential or 'non-firsthand' (as opposed to 'firsthand' for visual). Thus, even within perception, visual access has a privileged place.

In the Type II demonstrative/determiner variant of NPE, for e.g. ʔayʔaǰuθəm, where the choice between CDE and PDE ((14)–(15)) is dictated by the visibility of the referent at speech time (Huijsmans et al. 2020), can be captured with the same tools *as for nominal tense above*. As discussed above, this determiner system shares remarkable similarities with the nominal tense systems, in that the explicit temporal restriction has to interact with the flavor of evidence holding across historical alternatives:

(30)   Visual nominal: present (20) ⇔ CDE (Current Direct Evidence)
         $R_{visual-current-dem(<wt>,<e,w',t'>)} =_{def} \{< e, w, t > \ | \ \exists < w', t' >$
         $\in \mathbb{K}_{<w,t>} \ \text{SEE} \ (sp, e, w', t') \wedge t = t'\}$

(31)   Visual nominal: past (21) ⇔ PDE (Previous Direct Evidence)
         $R_{visual-previous-dem(<wt>,<e,w',t'>)} =_{def} \{< e, w, t > \ | \ \exists < w', t' >$
         $\in \mathbb{K}_{<w,t>} \ \text{SEE} \ (sp, e, w', t') \wedge t = t'\}$

Thus, the ʔayʔaǰuθəm CDE determiner ɬə (e.g. in (14)) is the lexical manifestation of the accessibility relation in (30), thus requiring visual access to the referent at a historical alternative that includes the speech time; while the ʔayʔaǰuθəm PDE determiner šə (e.g. in (15)) is the lexical spellout of the accessibility relation in (31), requiring that visual access to the referent held at a historical alternative not including speech time (thus necessarily, prior to speech time). With these analyses, we are able to maintain a **unified view** of all NPE systems (including nominal tense systems, Type I demonstrative/determiner systems which have a visual/ nonvisual divide and Type II demonstrative/determiner systems which have a speech time/non-speech time divide), using the *same* ingredients in the semantics of all evidentials.

A quick postlude to describe our stance on an important distinction: we have been modeling the result of obtaining perceptual evidence as adding to an agent's knowledge, and not beliefs. This might a priori appear to be too strong, because agents are capable of being mistaken in perception. For eg., a white and gold dress may appear to be blue and black under a certain light (cf. the viral internet sensation 'The Dress' in 2015 that spurred many scientific studies in human vision; Lafer-Sousa et al. 2015); bird A's call may be mistaken to be bird B's call in a noisy environment, etc. Thus, the interaction of aspects of the environment and human perception may lead to spurious correlations unbeknownst to the agent. However, *linguistically*

speaking, DIRECT evidentials do not allow contradictory continuations. For example, Murray (2010: 54) reports the following infelicitous judgment with the Cheyenne direct evidential, reflecting the 'apparent certainty of direct evidence' (AnderBois 2014: 240):

(32)   #É-hótaheva-Ø Floyd naa oha   é-sáa-hótahévá-he-Ø
         3-win-DIR.3SG   Floyd and CNTR 3-neg-win-MOD$_a$-DIR
         'Floyd won, I'm sure, but I'm certain he didn't.'

Other scholars have also noted how direct evidentials often strengthen the force of a plain assertion (Faller 2002; Birner et al. 2007; Davis et al. 2007), whereby a presence of the direct evidential is taken to be a higher indication of the strength of commitment than its absence.

Usually, if a cooperative agent is not certain of their sensory input, a qualification is provided: *I think I heard a European robin, but I am not sure*, or *There appears to be a tiger hiding in that dark shed but don't quote me on that.* Convincingly distinguishing belief from knowledge is the task of the epistemologist, one that I do not take on here.[13] But we can acknowledge McCready's (2014) observation (see also Stanley 2005 and Davis et al. 2007) here – to assert a proposition, knowledge or even total belief is not necessary; belief beyond reasonable doubt often suffices. So, from a philosophical point of view perception may build beliefs only leaving room for uncertainty/ retraction/revision, but from a linguistic point of view, DIRECT evidentials feed knowledge.

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[13] Indeed, the body of work on the epistemology of perception is massive (see Grice 1962; Lewis 1980; Dretske 1981; Searle et al. 1983; Armstrong 1991; Burge 1991; McDowell 1991; Searle 1991; Davies 1992; Owens et al. 1992; Soteriou 2000; Prinz 2006; Brewer 2011, among many others). A few key notions stand out as particularly relevant to our discussion here. Prinz (2006) argues for a refinement within Dretske's notion of epistemic seeing, into the notions of *recognitional seeing* (which is visual perception and necessarily factive recognition of an object) and *seeing-as* (which is often a nonfactive reconstrual of a perceived object). Prinz points out that Dretske does not particularly discuss cases of nonfactive seeing, where an agent is mistaken in their perception. Brewer (2011) similarly discusses the possibility of falsehood with respect to our perceptual relationship with the physical world. He characterizes visual illusion as a "perceptual experience in which a physical object, *o*, looks *F*, although *o* is not actually *F*" (Brewer 2011: 73). One example he provides is of a pair of parallel lines of equal length a metre away directly in front of an agent may be perceived as being of unequal lengths or unparallel. However, the margin of error cannot be extreme in that these lines cannot be mistaken for two circles. If so happens, then we are in the land of hallucination and not illusion. This kind of a crucial link between the presentation of physical objects in our perceptual ethos and our possibly faulty engagement with these objects (albeit within reason) due to limits of human perception forms the core basis for allowing room for deniability of the factivity of perception in the philosophical literature. However, given overwhelming evidence that natural languages do not allow the same speaker to contradict their claims of perceptual evidence for a proposition, we will proceed with the assumption that linguistically encoded perceptual evidence is factive.

8.4 Analysis: Inference

Making an inference is a very involved process in intelligent agents, one that involves premises and conclusions intermingled with the nature of available evidence. Within the landscape of evidentiality, a basic divide exists between two types of inferential processes as lexically manifested in evidentials. The two types are *inference via reasoning* (henceforth, reasoning) and *inference via results* (henceforth, results) (Willett 1988 onwards). The category of reasoning is typically applied to propositions which are available to an agent purely through evaluating their validity relative to a consistent body of facts already known to the agent (our above-mentioned proto-knowledge or epistemic modal base). The category of results is more contingent on perception – without knowing anything previously about an event/situation, a rational agent can perceive the results of an occurrence/events and make an inference.

Representative examples of both types of inferences are below, from Gitksan (Peterson 2012: examples 9b–c). The INFERENTIAL *n'akw* is felicitous only in contexts with visible physical results, while =*ima* is felicitous in both reasoning and results contexts.

(33)   Reasoning context: *You're sitting at home talking about going berry-picking. It's August, and the berries are usually ripe this time of year on the Suskwa (a traditional picking ground).*
  a. mukw=**ima**=hl   maay'
      ripe=MOD=CND   berries
      'The berries might/must be ripe/Maybe the berries are ripe.'
  b. #**n'akw**=hl mukw=hl maa'y
      EVID=CND ripe=CND   berries
      'The berries must be ripe/Looks like the berries are ripe.'

(34)   Results context: *People are arriving home after a day of berry-picking up in the Suskwa. They're carrying buckets of berries, and their hands are all purple.*
  a. mukw=**ima**=hl   maay'
      ripe=MOD=CND   berries
      'The berries might/must be ripe/Maybe the berries are ripe.'
  b. **n'akw**=hl mukw=hl maa'y
      EVID=CND ripe=CND berries
      'The berries must be ripe/Looks like the berries are ripe.'

It is a given that in the latter scenario, there is still some amount of world knowledge that comes into play, that helps to link the premises obtained by perceptual evidence to the most obvious conclusions. This is why =*ima* is felicitous in a results context as well. Both types of inferences then are sensitive to pre-existing knowledge in important ways.

Let us see how far we can maintain the same ingredients from the previous section while providing a semantics for both genres of INFERENTIAL evidentials.

I am assuming, to begin with, that every agent has a body of knowledge or a knowledge base by virtue of being human.[14] This knowledge base is traditionally represented with an epistemic accessibility relation in modal logic (Hughes & Cresswell 1986, 1996; Kratzer 1991; Portner 2009; Hacquard 2011), as shown in (35). This relation gives us a set of world-time pairs such that in all those pairs the known facts in the world-time pair of evaluation ($<w, t>$) hold:

(35) $R_{epis} = \{<w,t> \mid <w',t'> \text{ is a world} - \text{time pair in which all the}$
         known facts in $<w,t>$ hold$\}$

Facts are represented as propositions, and propositions are sets of world-time pairs. Beginning with inference from pure reasoning, we can provide the following definition:

(36)   Inference: reasoning
         $R_{reasoning(<wt>,<w',t'>)} =_{def} \left\{<w,t> | \forall <w',t'> \left[R_{epis<wt>} \subseteq [\![\psi]\!]^{R_{epis}} \rightarrow <w',t'> \in [\![\psi]\!]^{R_{epis}}\right]\right\}$

The output of this relation is a set of world-time pairs where ψ holds iff ψ is entailed by the set of world-time pairs accessible via the epistemic accessibility relation. This formulation makes clear two notions: (i) an inference has to be compatible with what is already known, (ii) the inference is being made using only information that is epistemically accessible and nothing else. The accessibility relation in (36) reflects inference drawn from pure reasoning then.

In contrast, the other type of inference is based primarily on sensorily accessed consequences/results as evaluated against the same body of known facts. In (22), I had defined an accessibility relation based on visual evidence for a proposition. We can define that same relation on perceptual terms now (R_{P-P} stands for $R_{perceptual-proposition}$; it is the exact same definition as R_{V-P} in (22) with just the label now expanded to include the whole array of perceptual sources):

(37)   Expanded from (22) to include all perceptual processes:
         Perceptual proposition
         $R_{P-P(<w,t>,<w',t'>)} =_{def} \{<w,t> | \forall <w',t'> \in \mathbb{K}_{<w,t>} \wedge t \neq t', V_{<w',t'>}(\psi) = 1\}$

Consequently, inference by results can be defined via the following relation:

(38)   Inference: results
         $R_{results(<wt>,<w',t'>)} =_{def} \left\{<w,t> | \forall <w',t'> \left[R_{P-P<wt>} \subseteq [\![\psi]\!]^{R_{P-P}} \rightarrow <w',t'> \in [\![\psi]\!]^{R_{epis}}\right]\right\}$

The output of this relation is a set of world-time pairs such that each world-time pair is a ψ world-time pair if ψ is entailed by the set of world-time pairs subject to historical necessity. In this case, the space-time continuum directly

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[14] I am going to gloss over the detail of *whose* knowledge it is in every sentence, assuming the default to be the speaker. We can envisage building that information in by adding the restriction of an agent i in the formula. Nothing in the discussion about the representation of perception, inference, reasoning, etc. hinges on this choice.

influences an agent's epistemic state. In fact, by definition then, both reasoning (36) and results (38) feed knowledge, assuming a self-aware agent is sensitive to the consistency of her R_{epis}. Consequently, we predict that INFERENTIAL statements should not allow contradictory continuations either, and this prediction is empirically well supported. A representative minimal pair highlighting the difference between inference and third-party reports is below, from Central Alaskan Yup'ik, as reported in Krawczyk (2012: 24, 50):

(39)   a.   Aya-llru-**llini**-uq
              leave-PAST-INFER-IND-3RDSG
              Aya-ksaite-llru-yuka-a
              leave-NEG-PAST-think.that-3RDSG
              # 'Evidently, she left . . . I don't think that she left.'
        b.   Aya-llru-uq-**gguq**
              leave-PAST-3RDSG-HEARSAY
              Aya-ksaite-llru-yuka-a
              leave-NEG-PAST-think-that-3RDSG
              'It is said that she left . . . I don't think that she left.'

Similarly, Hindi (40) and Bangla (41) show disallowance of contradictory continuations after a statement of inference with periphrastic (verbal) evidential constructions:

(40)   **Lag-ta hain**   Ram   aur   Ravan   dost   ban   gay-e
        feel-HAB COP   Ram   and   Ravan   friend   become   go.PST-PERF
        hain, **#**   par   dost   nahi   ban-e   hain.
        COP,   but   friend NEG   become-PERF   COP
        Intended: 'It looks like Ram and Ravan have become
        friends, but they have not become friends.'

(41)   **Mon-e hoy**   Ram   aar   Rabon   bondhutyo   patieye-che,
        heart-LOC happen   Ram   and   Ravan   friendship   launch-PERF
        # kintu   ora   ekhono   bondhu   hoy-ni.
        but   they   yet   friend   happen-NEG
        Intended: 'It looks like Ram and Ravan have started a
        friendship, but they are not friends yet.'

In Section 8.3, we explored the connection between the simple past tense and the witnessing of events in a number of languages. In many of these languages, an agent's inferential reasoning is reflected in the aspectual system, especially in perfect, perfective, and resultative aspects (Aikhenvald 2018; Comrie 1976 suggests a diachronic link between these categories). Morphologically, perfect aspect shows up when the speaker wishes to signal that the proposition has been arrived at via inference from results (Turkic, Bulgarian, South Asian languages, Georgian; see Slobin & Aksu 1982; Bybee & Dahl 1989; Izvorski 1997; Bashir 2006, among others).

What can be a natural way to characterize the link between a completed event (assuming the definition of perfect aspect to be an event/process that is

taken to be completed in the past but is still relevant for present purposes) and inference based on results? The answer is readily available in an approach like the one laid out in (38) – the propositional content deduced via the perceptual relation subject to historical necessity can only be arrived at once a coherent picture of a past event is sensorily made accessible to an agent who was not present when the event/process occurred. A *present imperfective* aspect, on the other hand, would then be predicted to denote DIRECT evidentiality, and not an INDIRECT inference of any sort because the time of the event/process correlates directly with the speech time, or the internal temporal structure of the event is accessible during speech time. And this is indeed what we find in many aspectual systems (see Aikhenvald 2018 for an overview).[15]

The general concept of possessing INFERENTIAL (or REPORTATIVE) evidence entails that what is possessed is a *proposition*. By the very nature of the processes of inference and hearsay, the most natural communicative unit is one that has an assignable truth value and explicit truth conditions. In contrast, perception is often deployed in accessing objects/entities, in addition to propositional content that is accessed via sensory devices. We may now be in a position to suggest that this vital difference in subtypes of evidence is the answer to one of the questions we started out with – why do most NPE systems encode DIRECT (mostly visual; other senses to a lesser extent) evidence only?[16] The semantics given to perception versus inference in this chapter also underlines this difference – in that:

 (i) perception is a relation between entities and world-time pairs, while
(ii) inference is a relation between bodies of knowledge.

One of the key novel goals here has been the forging of a common definition of perception across perceived nominals and perceived propositions – via historical necessity in both cases. This discussion may naturally raise the question of why more languages *do not* exhibit nominal visual evidentiality? There is no satisfying answer to this typological question to be found in current formal theories of evidentiality, and I leave it for future work.

8.5   Conclusion

In the vast literature on the phenomenon of evidentiality, there is surprisingly little technical clarity about what the formal definition of *evidence* is. Many major

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[15] One note about Korean: Korean appears to be different from the host of languages cited above in that the simple past tense corresponds to INDIRECT evidence/inference, and only the present tense can signal DIRECT evidence. I suggest this difference is because Korean does not employ aspectual distinctions in the evidentiality paradigm, and thus does not have a tension between tense and aspect with regard to signaling distinct flavors of evidence.

[16] In the only known exceptions of Jarawara and Illongo, "reportative evidentials" attached to nominals function like nominal adverbs, such as *purported thief*, *alleged robber*, etc., which can be argued to have a semantics different from core evidentiality.

accounts take the notion of evidence to be a primitive (see McCready 2014 for a detailed overview). Consider for example two representative examples from presuppositional accounts of evidentials (some of which are Izvorski 1997 for Bulgarian; Matthewson et al. 2007 for St'át'imcets; Peterson 2008, 2010 for Gitksan; Sauerland & Schenner 2007 for German and Bulgarian, among others).

(42)   Bulgarian perfect (INDIRECT)   (Izvorski 1997; Peterson 2012: example 36)
         Assuming the following:
         $B = \{p$: a speaker considers p indirect evidence in $w\}$
         $B(w) = \{u \in W : \forall p \ [(p$ is **indirect evidence** in $w) \rightarrow u \in p]\}$
         $g(w) = \{p$: a speaker believes p with respect to the indirect evidence in $w\}$
         then, an evidential statement EVp is denoted by:
         $[\![EVp]\!]^{c,w} = 1$ iff for $\forall w' \in O_{g(w)}(B(w)) : [\![p(w')]\!]^{c,w} = 1$.

(43)   St'át'imcets k'a (INFERENTIAL)   (Matthewson et al. 2007: 245)
         $[\![k$'$a]\!]^{c,w}$ is only defined if c provides a modal base B such that for all worlds
         $w' \in B(w)$, the **inferential evidence** in w holds in w', and f is a choice
         function such that $f(B(w)) \subseteq B(w)$.
         If defined, $[\![k$'$a]\!]^{c,w} = \lambda f.\lambda p.\forall w'[w' \in f(B(w)) \rightarrow p(w') = 1]$

In these formulations, we see a monolithic statement of evidence type. McCready observes that the concept of evidence is "not epistemologically innocent," since it is not a trivial assumption to make that the correct piece of evidence that is of the desired flavor that can induce the sufficient amount of conviction will be found in order to meet the definedness conditions formulated above. McCready makes the same argument for extensional accounts of spatio-temporality which assumes a monolithic notion of evidence that is not technically defined. Chung's (2007) *v-trace* function is as follows, that tracks spatio-temporal information relating to evidence for an event:

(44)   *v-trace* $(e) = \{<\text{t,l}> \mid \exists v[\text{EVIDENCE-FOR}(v,e) \land \text{AT}(v,t,l)]\}$, where $\text{AT}(v,t,l)$
         is true iff **the evidence** v for the occurrence of the eventuality e appears at a
         location l at time t.

In the study of variable force evidentials such as in Gitksan, St'át'imcets, Cuzco Quechua, and Nletkepmxcin, it is evident that the same evidential is ambiguous between a reading where the speaker is fairly certain of the truth of the proposition/reliability of the source and where they are not/they are neutral. For example, the Gitksan REPORTATIVE *kat* can have a reading with a personal report and a neutral/less certain *apparently* (Peterson 2012: example 30):

(45)   lumakt-i-(t)=**kat**=s   John=hl   daala
         donate-TR-3=REP=PND   John=CND money
         'I heard John put in money (for the feast).'
         'Apparently, John put in money.'

Matthewson et al. (2007), Littell et al. (2010), and Peterson (2010, 2012) argue for an epistemic modal analysis of such markers, where existential or

universal modal force is correlated directly with the measure of the speaker's confidence. While I am in agreement with the general principle in these works of modeling certainty/reliability as a core property of evidentials (one that cannot be straightforwardly modeled in extensional semantics), the definitional absence of evidence leaves a gap in terms of both predictability and testability.

We cannot have a good theory of evidentiality without defining what evidence is. Sharing McCready's concerns over the lack of theoretical clarity, I have suggested here that a nature-of-evidence-informed modal analysis is a superior approach, since it can also accommodate the interaction of tense with evidentiality. I have directly encoded the subtype of evidence in the semantics, in arguing that three distinct flavors of evidentiality embody three distinct spatio-temporal modal accessibility relations:

  (i) DIRECT (sensory) evidentials = a temporally sensitive historical necessity relation (yielding the factive nature of perception);
 (ii) INFERENTIAL evidentials of pure reasoning = an epistemic accessibility relation;
(iii) INFERENTIAL evidentials of results = a combination of the above two.

Given that the nature of evidence is formally defined in this approach, the force of quantification over accessible world-time pairs where that kind of evidence holds can be more straightforwardly correlated with the agent's evaluation of and certainty about the reliability of the source. A desirable consequence of this approach is its potential applicability in the computational-linguistic aspects of analysis of social and political discourse in the modern world which is rife with concerns about discerning disinformation, fake news, and engineered falsehoods aimed at delegitimizing objective truth, an area of research I leave for future collaborative work.

The theory presented here also highlighted the link between information about the space and time coordinates of the acquisition and processing of evidence and overt lexical choices in a diverse set of languages. This approach was shown to be defensible for both propositional and non-propositional evidentiality (evidentials scoping over propositions and nominals, respectively), thus unifying these domains for the first time. Our discussion also explored some aspects of the cognitive underpinnings of perception, with some juxtaposition with the epistemology of perception. This spatio-temporal modal analysis, while accounting for languages where these categories interact morphologically, can also account for languages where we do not see the same interactions play out on the surface but can assume they hold, given the language-independent processes of perception, inference, temporality, reasoning about causality, and acquisition of beliefs.

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