Pragmatic Effects on Semantic Learnability:

Insights from Evidentiality

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Abstract

Cross-linguistically prevalent semantic distinctions are widely assumed to be easier to learn because they reflect natural concepts. Here we propose an alternative, *pragmatic* perspective that links both the cross-linguistic prevalence and the learnability of semantic distinctions to communicative pressures. We focus on evidentiality (the encoding of the speaker's information source). Across languages, grammatical evidential systems are more likely to encode indirect sources (especially, reported information) compared to direct sources (e.g., visual perception). On a conceptual account, this seems puzzling, since humans reason naturally about how seeing connects to knowing. On a pragmatic account, however, the predominant encoding of the speaker's reportative compared to visual information sources can be explained in terms of informativeness (visual access is ubiquitous and potentially more reliable, hence less marked). We tested the pragmatic account in four experiments. Adult English speakers exposed to novel miniature evidential morphological systems consistently showed higher learning rates for systems with a single indirect (reportative) compared to a single direct (visual) evidential morpheme (Experiment 1). This pattern persisted even when participants were given specific cues to the target meanings (Experiment 2) and partly extended to cases where evidential meanings were conveyed through visual, not linguistic, means (Experiment 3). It also persisted when the evidential morphemes had to be learned from different materials (Experiment 4). We conclude that the cross-linguistic bias to mark reportative/indirect over visual/direct sources of information has pragmatic roots that also shape the learnability of evidential semantic distinctions.

Keywords: pragmatics, evidentiality, semantics, learnability, informativeness, artificial language learning

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1. Introduction

1.1. The learnability of semantic distinctions

Within cognitive science, it is often assumed that linguistic distinctions that are encountered more frequently across different languages share some characteristics that make them easier to learn than others (Jacobson, 1971; Rosch, 1972; Clark, 1976; Pinker, 1984; Slobin, 1985; Bowerman, 1993). A well-known version of this idea appears in Gentner and Bowerman's (2009, p. 467) Typological Prevalence Hypothesis (TPH): "All else being equal, within a given domain, the more frequently a given way of categorizing is found in the languages of the world, the more natural it is for human cognizers, hence the easier it will be for children to learn". However, until recently, explicit evidence for this proposal in the domain of meaning has been hard to come by, and empirical tests of the TPH have yielded data that are complicated to explain. This is because cross-linguistic similarities in lexical learning could well reflect the complexity or naturalness of the underlying concepts, as the TPH expects (Gentner & Bowerman, 2009; Johnston & Slobin, 1979) but might also or instead reflect factors about how learners map words onto already available concepts (e.g., Gleitman, 1990).

In this paper, we revisit the link between the cross-linguistic frequency and learnability of semantic phenomena and propose an alternative, *pragmatic* perspective that links both phenomena to communicative pressures. On this perspective, what learners find easy or hard to learn is determined not (only) by what is easy or hard to conceptualize but by what sorts of distinctions are more or less likely to be pragmatically useful (e.g., informative) and thus likely to be chosen for encoding by a speaker during conversation. This perspective introduces an additional or alternative explanation for the nature and acquisition of semantic meanings: because pragmatic pressures in communication are universal (Sperber

& Wilson, 1986; Grice, 1989), pragmatic factors can explain both cross-linguistically robust preferences to single out and encode specific classes of meaning and strong learning preferences during the acquisition of semantic distinctions.

Our experimental investigations focus on the semantic domain of evidentiality (i.e., the linguistic encoding of the speaker's information source). We adopt an Artificial Language Learning design in which we expose participants to miniature semantic systems that themselves vary in typologically prevalence and compare their learnability. This approach has been used extensively in the study of morpho-syntactic (Smith & Tsimpli, 1991; Christiansen, 2000; Newport & Aslin, 2004; Hudson Kam & Newport, 2005, 2009; Thompson & Newport, 2007; Wonnacott, Newport & Tanenhaus, 2008; Tily, Frank & Jaeger, 2011; Merkx, Rastle & Davis, 2011; Culbertson & Smolensky, 2012; Fedzechkina, Jaeger & Newport, 2012; Tabullo, Arismendi, Wainselboim, Primero, Vernis, Segura, Zanutto & Yorio, 2012; Culbertson, Franck, Braquet, Barrera Navarro & Arnon, 2020) and phonological phenomena (Seidl & Buckley, 2005; Wilson, 2006; Finley & Badecker, 2009), and has only recently been extended to semantics (Xu, Dowman & Griffiths, 2013; Carstensen, Xu, Smith & Regier, 2015; Kemp, Xu & Regier, 2018; Maldonado & Culbertson, 2020; Saratsli, Bartell & Papafragou, 2020). In a series of experiments, we confirm the expectation that frequently expressed evidential meanings are also easy to acquire (see also Saratsli et al., 2020). However, we provide evidence that the roots of this asymmetry are pragmatic in nature.

1.2. Evidential distinctions cross-linguistically

Evidentiality refers to the different ways that language marks how the speaker got to know what happened (their source of information), such as perception, inference and verbal report (Willett, 1988; Aikhenvald, 2004, 2014, 2018a; de Haan, 2013). Perception mostly includes visual experience and can sometimes refer to non-visual perception (information acquired through hearing or other senses; Aikhenvald, 2018a). Inference as an information source can include inference from visual premises, general knowledge or other types of reasoning. The source category of verbal reports includes cases of hearsay (where source of the report is left unspecified) and quotative cases (where a specific entity is quoted as the source).

Languages employ different tools to encode evidential distinctions (Chafe & Nichols, 1986; Kratzer, 1991; Cinque, 1999; Johanson & Utas, 2000; Ifantidou, 2001; Mushin, 2001; Delancey, 2002; Aikhenvald & Dixon, 2003, 2014; McCready & Ogata, 2007; McCready, 2008; Aikhenvald, 2004, 2014, 2018a). Many languages encode evidentiality through lexical means (e.g., in English, verbs such as *see, hear* or adverbs such as *reportedly*) but a quarter of the world's languages use grammatical morphemes to indicate information sources (Izvorski, 1998; Garrett, 2000; Faller, 2012, 2014; Matthewson, 2012; Speas, 2004, 2018; Anderbois, 2014; San Roque, 2019; Murray, 2021; Kalt, 2021). For instance, in Turkish, *-di* marks direct perceptual access to the event and *-mış* marks inferential or hearsay access (see Ünal & Papafragou, 2018).

(1) Ali futbol oyna-dı.
Ali football play-PAST-DIR.EV.
"Ali played soccer (I saw)".

(2) Ali futbol oyna-mış.
Ali football play-PAST-INDIR.EV.
"Ali played soccer (I heard/inferred)".

For present purposes, we focus on the observation that, cross-linguistically, evidential systems that mark indirect (inference- or hearsay-based) access to information are more prevalent compared to systems that mark direct (perception-based) access (de Haan, 2013; Aikhenvald, 2003, 2004, 2018a). For instance, the World Atlas of Languages lists 161 languages from distinct families that grammatically mark only indirect evidence, 71 languages that mark both direct and indirect evidence and no languages that mark direct evidence alone (de Haan, 2013). Additionally, when languages only have a single evidential morpheme, this morpheme most often marks reportative information (or, less frequently, both inference and reports) while other types of information sources remain unmarked (Aikhenvald 2003, 2004, 2018). Systems that mark only direct (visual) access with dedicated grammatical devices but do not grammatically encode other source types are unattested (ibid.). These facts suggest a markedness hierarchy for evidentiality, with direct (visual) evidence being the unmarked case.

1.3. The learnability of evidential distinctions

If (as suggested above) direct visual access to information is the least frequently marked morphological distinction in the domain of evidentiality, it should also be the least learnable. This expectation was borne out in a recent series of Artificial Language Learning experiments by Saratsli et. al. (2020) in which participants were exposed to miniature morphological systems encoding a single evidential category (visual, inferential or reportative access to information). Results showed that the evidential system that marked reportative access was consistently easier for participants to learn and the system that marked visual access was the hardest to learn.

How can the learnability results be explained? These patterns sit uneasily with the idea that both typological frequency and learnability index the 'naturalness' of the underlying concepts (Gentner & Bowerman, 2009, a.o.), since visual perception is known to be a salient, important and natural conceptual category. Developmental evidence suggests that children from early on can reason about visual access and treat it as a reliable source of knowledge (Pillow, 1989; Pratt & Bryant, 1990; Ozturk & Papafragou, 2016). The link between seeing and knowing is also understood by non-human primates (Hare, Call & Tomasello, 2001; Call & Carpenter, 2001). Visual perception is richly represented in verb meanings across languages (e.g., Viberg, 1984; San Roque et al., 2015; 2018; Majid et al., 2018), and these meanings often get extended to refer to other cognitive processes in ways that are not true of other senses (e.g., in English, *see* can mean 'realize'; San Roque et al., 2018; Sweetser, 1990). Moreover, the fact that vision gives access to information seems to be available to both seeing and blind individuals (Landau & Gleitman, 1985; Koster-Hale, Bedny & Saxe, 2014).

On an alternative explanation, both the typological facts about evidential systems and the corresponding learnability asymmetries can be related to the pragmatic implications carried by different sources of information. Direct visual access is generally (even though not always) considered to be more reliable due to the correspondence of the speaker's experience with reality compared to less direct sources that can depend on incomplete inferential premises or an informant's reliability (Dancy, 1985; Papafragou et al., 2007; Matsui & Fitneva, 2009; Koring & De Mulder, 2015; Aikhenvald, 2018a; Wiemer, 2018). According to this pragmatic perspective, visual perception is a prevalent, reliable source of information for humans but when *one* evidential meaning is singled out to be encoded in a morpheme, it is unlikely to correspond to the predominant information source that humans rely on. Since evidential morphology always involves a first-person perspective (unlike lexical verbs that can be used to report other people's access in addition to own's own; Speas, 2018), humans mark the source of their own knowledge in an evidential device when it is *informative* to do so – when the source is newsworthy, that is, has novel cognitive consequences (e.g., it is unreliable). According to this perspective, non-perceptual sources are selectively marked in languages that have a single evidential morpheme because they are informative, i.e., they represent a departure from the primacy of perception as an information source (cf. Barnard, Rosen & Matthews, 2017, on a similar notion of informativeness). Furthermore, given that reportative access is the least direct type of information source (since the speaker need have experienced no part of an event), it would be the most likely to be encoded when languages have a single evidential morpheme. This perspective coheres with (and explains) the prior observation that "the tendency to mark direct, or visual, or sensory evidentials less than others may reflect the primacy of vision as an information source" (Aikhenvald, 2018a, p.16).

This pragmatic explanation is consistent with proposals according to which human cognition is equipped with epistemic vigilance so as to avoid unreliable sources and the risk of being misinformed (Sperber, Clement, Heintz, Mascaro, Mercier, Origgi & Wilson, 2010). We know that even young children track a speaker's trustworthiness and choose to learn things from reliable over unreliable speakers (Sabbagh & Baldwin, 2001; Koenig & Harris, 2005; Jaswal & Neely, 2006; Mascaro & Sperber, 2009; Jaswal, 2010; Fusaro, Corriveau & Harris, 2011; Harris, 2012; Koenig, 2012). However, constantly exercising epistemic vigilance could entail an additional processing cost: the assumption that human communication is presumed to be truthful and informative (Grice, 1989) would be violated and speakers would need to evaluate not only the actual information they receive but also their interlocutor's reliability and intentions. One way of providing essential information within a fully cooperative communicative context without overtaxing epistemic vigilance would be to only mark indirect, potentially unreliable – but not direct perceptual, presumably more reliable - sources of one's experience.

At present, the pragmatic explanation for the learnability of evidential distinctions remains untested. In Saratsli et. al. (2020), because of design complexities, the fact that the visual evidential was hard to learn did not uniquely point to pragmatic factors (but could have arisen, e.g., from the difficulty of differentiating visual from inferential access to information in the specific scenarios used in the study; cf. Johnson, Hashtroudi & Lindsay, 1993; Hannigan & Reinitz, 2001; Ünal, Pinto, Bunger & Papafragou, 2016). In what follows, we put the pragmatic explanation for the acquisition of evidentiality to a direct test using a simple design. In Experiment 1, using an Artificial Language paradigm, we compared the learnability of only two evidential systems, one that marks reported information (Reportative System) and one that marks visual perception (Visual System). We reasoned that, even in this highly contrastive design, the pragmatic account predicts that the Reportative system should be easier to learn. In Experiment 2, we replicated the study but told participants explicitly that the meaning they had to acquire related to one's information access. According to the pragmatic account, this addition should not affect the learnability data: even if participants know the kind of meaning they should hypothesize, pragmatic reasons still disfavor visual evidentials. In Experiment 3, we asked whether the learnability patterns observed for evidential morphology would also generalize to non-linguistic (visual) markers of evidential categories. If pragmatic factors were responsible for the learnability of morphological distinctions, the results should persist as long as the task continues to involve a manifest communicative intention. Finally, in Experiment 4, we removed an alternative, methodological explanation for these findings.

2. Data Availability

The data collected, code and analysis reports for each of the four experiments along with the stimuli used can be found in the following Open Science Framework (OSF) repository: https://osf.io/2d9x3/?view_only=d643244717d849af87bf621296a4beeb .

3. Experiment 1

3.1. Methods

3.1.1. Participants

We recruited 64 participants between the ages of 18 and 70. Almost all were undergraduate students at the University of Delaware that participated for course credit, except for 6 individuals recruited through Amazon Mechanical Turk after the subject pool closed. There was no difference in performance between the two samples. All participants were native speakers of English and none of them reported speaking an additional language at home or a language that included grammatical evidentials. Since evidentiality is not grammatically marked in English, having native English speakers as our participants in this and the following experiments ensured that there would be no native language interference on learnability patterns.

3.1.2. Stimuli

Our stimuli were comprised of 42 videos (a subset of the videos used in Saratsli et al., 2020). Each video had two versions, with each version corresponding to a type of information access (Visual or Reportative). A complete list of the events in the videos for this experiment can be found in Appendix A. Each video depicted an event involving three characters. One of the characters performed an action ("the Agent") while the second character either fully witnessed this action (Visual Access version) or was informed about what happened without having any type of visual experience of the event (Reportative Access version). At the end of the video, this second character ("the Speaker") turned to the camera and described what happened. The third character manipulated whether the Speaker has access to the event by either allowing her to watch what happened or by blocking her visual access throughout the event. The same three, female undergraduate research assistants appeared in all videos and their roles remained constant throughout the different events. The event setting was also kept identical across the different videos with the Agent and the Speaker sitting at the opposite sides of a table while the third character was standing behind the Speaker.

An example of an event can be seen in Figure 1. For the Visual Access (Panel section A), the Speaker had continuous direct visual access while the Agent performed the event (she lit a lamp, panels A2-A4). To make these videos comparable to the Reportative Access ones, the Speaker's eyes were blocked by the third character in the beginning of all the Visual Access events (A1) but then the Speaker gained Access to the complete event (A2-4). For the Reportative Access (Panel section B), the Speaker's eyes were blocked throughout the event by the third character (B1-3). After the Agent had completed the event and took the materials away from the table, the third character uncovered the Speaker's eyes and was shown whispering to her (B4). For both access types, the video ended with the Speaker turning to the camera to describe what happened (Panel 5). At that time, a speech bubble appeared, containing a sentence in the target artificial language and remained on the screen for approximately 8 seconds before the next video started.

The artificial language had Subject-Object-Verb word order and lacked determiners but otherwise contained English words. The sentences in that language either contained a novel evidential morpheme, *ga*, at the end of the verb, marking the character's access to the event (*She lamp litga*) or omitted the evidential (*She lamp lit*). We constructed two evidential systems (Visual and Reportative) depending on which type of Access was marked with *ga*; within each system, the events corresponding to the other type of access were described using plain (unmarked) sentences.

Figure 1. Sample screenshots from versions of a single dynamic video in Experiment 1 in which a character gained access to an event (someone lighting a lamp) either through visual access (A) or verbal report (B).

Our experimental paradigm consisted of a Training Phase in which participants were exposed to the events and the use of the artificial language and a subsequent Testing Phase, in which participants' ability to use (Production Task) and interpret (Comprehension Task) the novel morpheme was assessed. As mentioned before, each event was filmed in two versions depending on the Speaker's Access to the event (Visual or Reportative). This allowed us to create two counterbalancing lists by rotating the Speaker's access to the event (i.e., if a certain video in list 1 showed the Speaker having Visual Access to the event, the same video in list 2 would show the Speaker having Reportative access to the same event). For each list, we created two different presentation orders for each evidential system, resulting in four different randomized presentation lists per evidential system.

3.1.3. Procedure

Participants were tested through the use of one of two online platforms. Participants that received course credit were invited to connect through a Zoom session. Stimuli were displayed on the researcher's computer and screen shared with participants. Prior to the experimental session, participants were provided with an individual response sheet that they needed to fill out on Qualtrics at the time of the study. For participants that were recruited through Amazon Mechanical Turk (https://www.mturk.com/), the procedure remained the same but individual sessions were administered through Ibex PennController (Zehr & Schwarz, 2018).

Participants were randomly assigned to one of the two evidential systems (Visual or Reportative) and to one of the four corresponding presentation lists of that evidential system. In the beginning of the experimental session, participants were provided with a detailed description of the setting of the events:

> "You will watch a series of short clips involving three characters: in each clip, one character will perform an action on some object(s) and then put the objects away. A second character will learn about this action in different ways depending on what a third character does. After this, the second character will describe what happened. This will be depicted in a speech bubble onscreen."

Next, a still image of the three characters in the visual setting was displayed in an effort to familiarize participants with the content of the stimuli before the actual videos began. Participants were then provided with the following instructions for the Training Phase, including details about the artificial language to which they would be exposed and what they needed to do:

> "The characters will be speaking an alien language: it shares some words with English but it is different in several ways. One difference is that the language includes a special marker: "ga." You will have to pay attention to when "ga" appears in order to try and figure out what it means. You will go through several events to try to learn the language and figure this out."

Before the videos started, participants were also informed that there would be a second part in which their understanding of where *ga* appeared based on its meaning would be assessed. The Training Phase included 10 videos in total, 5 videos for each Access type.

After this phase, participants were first presented with the Production and later the Comprehension Task. For the Production Task, we used 8 new videos, 4 videos for each type of Access (Visual or Reportative). The setting and structure of the videos displayed was identical to the videos shown in the Training Phase but when the speech bubble appeared at the end of the video, there was a gap next to the verb where the evidential marker could be placed and participants had to decide whether the marker should be used or omitted. The specific instructions that participants read were as follows:

> "We will now show you a new series of clips. Here you will be asked to help describe some events using the marker "ga" in the alien language. Almost everything will be the same as before, but this time no marker is included in the speech bubble.
> For each clip, there is a textbox. Please type in either the verb with the marker that is needed or only the verb if no marker is needed in order to complete the speech bubble."

After given some time to thoroughly read and fully understand the instructions (approximately 15 seconds), participants were shown a sentence example that did not appear in the actual task so as for them to get a more precise idea of what their answer should be. This model sentence was: "She piano played_" and participants were explicitly told that they should type either the plain verb ("played") or the verb along with the marker ("playedga") depending on whether they thought the marker was needed for each given trial considering what they figured out from the first part of the experiment.

For the Comprehension task, we used 24 videos, 12 per each Access type. For half of the events the Speaker erroneously used the morpheme *ga*, either by omitting the morpheme when it should have been used or by using it for the wrong type of access. For the remaining half of the scenarios, the use of the morpheme was correct. Participants had to type in either "yes" or "no" depending on whether they thought the character was correctly using the morpheme or not. The specific instructions participants were given were the following:

> "We will now show you a third series of clips. Almost everything will be the same as when you paid attention to when "ga" is used, but this time some of character's descriptions will contain errors: they will omit "ga" or include it when it is not needed.
> For each clip, please type **Yes or No** in the textbox provided to indicate whether the character's description **correctly** included or omitted "ga"."

After completing the Comprehension Task, participants were asked to indicate what they thought the marker *ga* meant and when it was used.

3.2. Results

Participants' responses were coded as a binary outcome variable (using 1 for a correct response or 0 for an incorrect response), reflecting their accuracy in each task. The data summary for each task can be seen in Figure 2. A logistic mixed-effects modeling was used for the data (Baayen, 2008; Baayen, Davidson & Bates, 2008), implementing the generalized binomial linear mixed effects modeling (glmer) function of the lme4 package due to the presence of categorical variables (Bates, Maechler, Bolker & Walker, 2015). The data analysis was performed using the R Project for Statistical Computing (R Development Core Team, 2018).

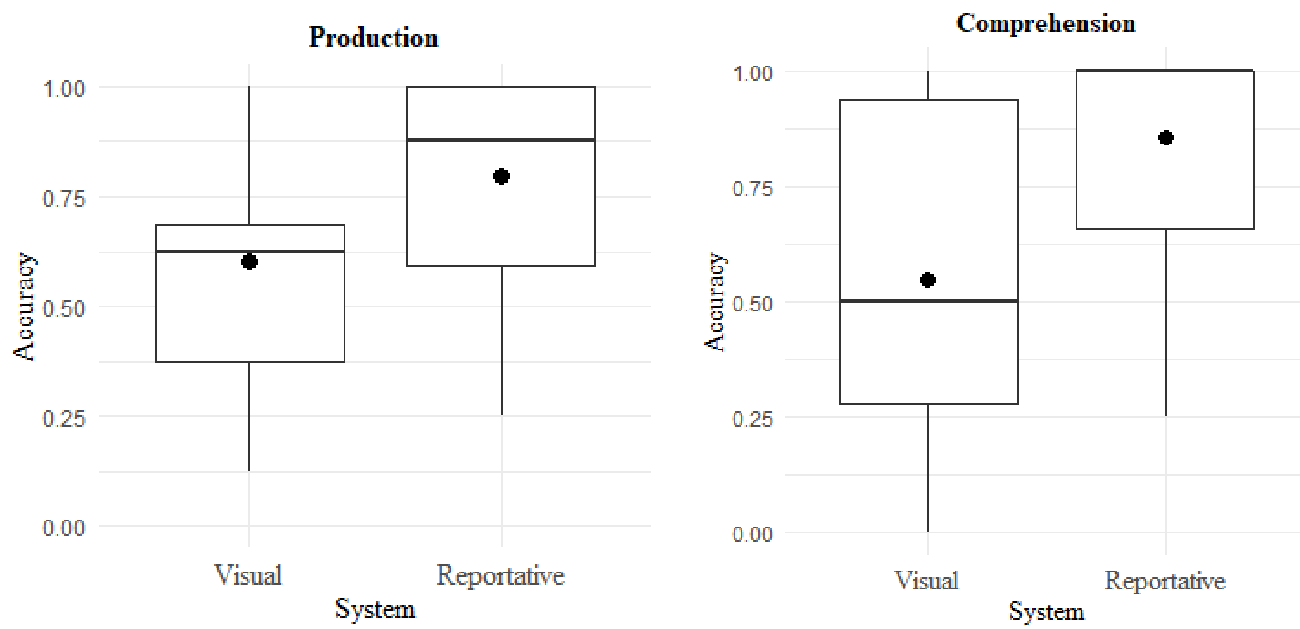

Figure 2. Accuracy score distribution, median (horizontal bar) and mean (dot) for each Evidential System in the Production and Comprehension tasks of Experiment 1.

For each of the two tasks, the mixed-effects model included participants' accuracy as the dependent variable and the type of evidential System (Visual, Reportative) as a fixed predictor along with random intercepts for Participants and Items. Since the fixed predictor of System only had two levels, its effect was assessed with one planned comparison between the Reportative and the Visual systems (contrast coding: -.50,.50).

For the Production task, including the fixed predictor in the model significantly improved the model fit based on a chi- square test of the change in -2 restricted log likelihood ($\chi^2 = 10.58$, $p = .001$). Participants showed higher accuracy rates for the Reportative compared to the Visual System (M_{Rep} = 0.79, M_{Vis} = 0.60). For the Comprehension task, we obtained similar results, with System significantly improving the model fit ($\chi^2 = 16.59$, $p < .001$): the Reportative System yielded higher accuracy rates compared to the Visual System (M_{Rep} = 0.85, M_{Vis} = 0.54). The parameter estimates of our models for both the Production and the Comprehension tasks can be found in Table 1.

Table 1. Parameter estimates for Accuracy in Experiment 1. Significance levels: * p < .05, ** p < .01, *** p < .001

Effects	Estimate	SE	Z
Production Task			
Intercept	1.18	0.21	5.41 ***
System (Reportative vs. Visual)	-1.26	0.39	-3.23 **
Comprehension Task			
Intercept	2.70	0.54	5.00 ***
System (Reportative vs. Visual)	-3.82	0.98	-3.87 ***

Participants' answers to the explicit question about the meaning and use of *ga* align with the accuracy rates observed in the two tasks. Ten of the 32 participants that were exposed to the Visual System correctly associated the morpheme with visual access to the event, specifically mentioning the verbs *see, watch* and *look*. Additionally, one participant did not directly associate the marker with visual evidence but instead with the fact that the third character did not whisper to the Speaker when the marker was used. Eight participants mistakenly associated the marker with the opposite (i.e., Reportative) access. The remaining 18 participants associated *ga* with irrelevant, non-evidential meanings (e.g., they mentioned other morphemes such as *the*, *a, -ed*, or other kinds of meanings, such as event completion). Of the 32 participants exposed to the Reportative System, 23 offered appropriate conjectures about the meaning of *ga*:15 participants associated the marker with the Speaker not knowing about the event and being told about what happened, 7 focused on the Speaker's lack of visual access, and the remaining 2 associated the marker with uncertainty and secret action. The rest of the participants provided meanings unrelated to evidentiality.

3.3. Discussion

It has long been assumed in the literature that, across languages, semantic distinctions that are more prevalent are also easier to learn. Previous studies in the domain of evidentiality have provided support for this assumption but have not determined the driving force behind the learnability patterns (Saratsli et al., 2020). Here we asked whether the ease of acquisition of evidential distinctions can be attributed to pragmatic (as opposed to conceptual) forces.

We exposed participants to one of two miniature evidential systems in a highly contrastive experimental setting with only two information sources. Our results show that the most typologically common (Reportative) evidential system was learned more easily compared to the less common (Visual) system. This pattern was confirmed by participants' explicit conjectures about what the marker meant: participants exposed to the Reportative System were more likely to explicitly associate the marker with the correct evidential meaning compared to participants exposed to the Visual System. Because reportative access is more informative (and potentially less reliable) compared to visual access, the current experiment offers support for the effect of pragmatic pressures on the learnability of semantic distinctions.

4. Experiment 2

If a pragmatic asymmetry within sub-types of evidential meanings drives the findings from Experiment 1, the learnability patterns should persist even if learners are explicitly told that the new morpheme encodes source of information. In Experiment 2, we replicated Experiment 1 but modified the instructions prior to the Training Phase to explicitly inform participants that the marker *ga* encoded the way that the speaker obtained information about an event.

4.1.Methods

4.1.1. Participants

We recruited 64 adult participants between the ages of 18 and 70. Participants were recruited mostly through the undergraduate subject pool at the University of Delaware and earned course credit for their participation (n = 52). A few were recruited through Amazon Mechanical Turk after the subject pool closed and received monetary compensation for their participation (n = 12). There was no difference in performance between the two sample groups. None of the participants had participated in Experiment 1. All were native speakers of English. Most of the participants did not speak a second language; in case participants were familiar with additional languages (mostly Spanish and French), these languages did not include grammatical evidentials.

4.1.2. Stimuli and Procedure

The stimuli and procedure were identical to Experiment 1. Participants were randomly assigned to one of two evidential systems (n = 30 for the Visual System and n = 29 for the Reportative System). We only modified the instructions participant received prior to the Training Phase in the following way (marked in bold font):

> "The characters will be speaking an alien language: it shares some words with English but it is different in several ways. One difference is that the language includes a special marker: "ga." **This marker shows how a speaker gets to know about what happened.**
>
> You will have to pay attention to when "ga" appears in order to try and figure out what it means. You will go through several events to try to learn the language and figure this out."

4.2. Results

Participants' responses were coded for Accuracy for both Production and Comprehension. The summary results can be seen in Figure 3.

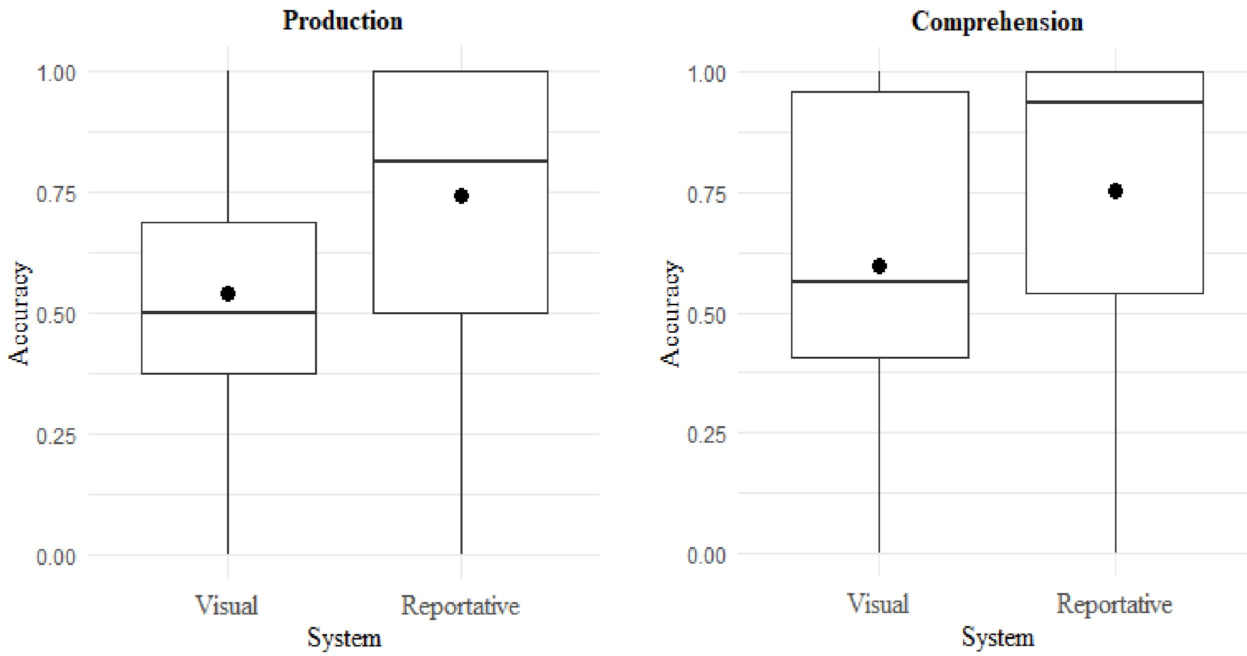

Figure 3. Accuracy score distribution, median (horizontal bar) and mean (dot) for each Evidential System in Experiment 2.

A mixed-effects model was built for each of the two tasks, using participants' Accuracy as the dependent variable and the evidential System (Visual, Reportative) as the fixed predictor. Each model also included random intercepts for Participants and Items. We used contrast coding to compare the accuracy scores of the Reportative System to those of the Visual System (-.50,.50). Our analysis for the Production task revealed that the fixed predictor System significantly improved the model fit based on a chi- square test of the change in -2 restricted log likelihood (χ^2 = 7.02, p = .008): participants' accuracy rates in the Reportative System were higher than the accuracy rates observed in the Visual System (M_{Rep} = 0.74, M_{Vis} = 0.54). Turning to the Comprehension task, including System in our model improved model fit (χ^2 = 5.10, p = 0.02): again accuracy was higher in the Reportative compared to the Visual System (M_{Rep} = 0.75, M_{Vis} = 0.60). All parameter estimates for each model can be found in Table 2.

Table 2. Parameter estimates for Accuracy in Experiment 2. Significance levels: * $p < .05$, ** $p < .01$, *** $p < .001$

Effects	Estimate	SE	z
Production Task			
Intercept	1.01	0.27	3.70 ***
System (Reportative vs. Visual)	-1.38	0.52	-2.64 *
Comprehension Task			
Intercept	1.68	0.39	4.26 ***
System (Reportative vs. Visual)	-1.69	0.75	-2.23 *

The participants' explicit conjectures about the marker's usage revealed a pattern similar to that of Experiment 1. Of the 32 participants exposed to the Visual System, only 11 associated the marker with the character's visual access to the event. Four participants incorrectly associated the marker with the opposite (i.e., Reportative) access, and the rest mentioned meanings unrelated to evidentiality (past or completed actions, articles such as *the*/*a,* and the plural form for the noun included in the sentence). Of the 32 participants exposed to the Reportative System, 14 correctly associated *ga* with reportative access, specifically mentioning that the marker was used when the speaker "was told" about the event, and another 4 mentioned the speaker's lack of visual access. The remaining participants associated the morpheme with irrelevant meanings.

Finally, we compared the accuracy rates for the Production and the Comprehension task separately across Experiments 1 and 2 (see Table 3). Starting with the Production task, we used a mixed-effect logistic regression model, with Accuracy as the dependent variable, System (Visual, Reportative) and Experiment (Exp.1 – Original Instructions, Exp.2 – Modified Instructions) as fixed predictors, and random intercepts for Items and Participants. Our results showed that System significantly improved our model based on a chi- square test of the change in -2 restricted log likelihood (χ^2 = 16.99, p < .001). Experiment (χ^2 = 1.18, p = .27) and the interaction between the two fixed factors (χ^2 = 0.01, p = .90) led to no such improvement. This shows that participants' production was similar across the two experiments despite the modified instructions of Experiment 2 and only differed depending on the System they learned (M_{Rep} = 0.76, M_{Vis} = 0.57).

Table 3. Parameter estimates for Accuracy in the Production and Comprehension tasks of Experiments 1 and 2. Significance levels: * p < .05, ** p < .01, *** p < .001

Effects	Estimate	SE	z
Production Task			
Intercept	1.09	0.16	6.44 ***
System (Reportative vs. Visual)	-1.32	0.32	-4.13 ***
Experiment (1 vs. 2)	-0.34	0.31	-1.09
System* Experiment	0.07	0.62	0.11
Comprehension Task			
Intercept	2.12	0.31	6.69 ***
System (Reportative vs. Visual)	-2.65	0.59	-4.45 ***
Experiment (1 vs. 2)	-0.77	0.57	-1.34
System* Experiment	1.82	1.15	1.58

Turning to the Comprehension task, we used a similar mixed-effects regression model, including System and Experiment as fixed predictors and random intercepts for Items and Participants. As with the Production task, only System improved the model fit (χ^2 = 19.74, p < .0001) but Experiment (χ^2 = 1.43, p = .23) or its interaction with System (χ^2 = 2.50, p = .11) did not. Again, participants' performance was different across evidential Systems (M_{Rep} = 0.80, M_{Vis} = 0.57) but not across the two experiments.

4.3. Discussion

In Experiment 2, we used the same stimuli and procedure as in Experiment 1 but included an explicit clue about the evidential nature of the target morpheme. Our results replicated the learnability patterns obtained in Experiment 1: participants learned the Reportative System more easily compared to the (cross-linguistically less-attested) Visual System. Moreover, the clue included in the instructions did not boost participants' performance compared to Experiment 1. These findings strengthen the conclusion that the learnability advantage of Reportative over Visual evidential systems has a pragmatic explanation: even when the difficulty of identifying the abstract category of evidentiality as a candidate for learning was removed, participants still learned to encode certain kinds of information sources more easily compared to others – presumably because these meanings and their associated communicative contribution provided a more appropriate basis for linguistic marking.

5. Experiment 3

If the advantage of the Reportative System in our findings so far is due to pragmatic factors, the same advantage should occur even if the evidential distinctions are encoded through non-linguistic stimuli. This is because pragmatic principles are expected to characterize both linguistic and non-linguistic (e.g., pictorial) communicative systems (Grice, 1975; Sperber & Wilson, 1986; cf. also Richards, Kampa & Papafragou, 2019). In Experiment 3, we addressed this possibility. This experiment adopted the stimuli and structure of Experiment 1 but included no artificial language. Instead of a sentence with an evidential morpheme, a red frame appeared around the video (and instead of an unmarked sentence, a plain video without a red frame was shown). The participants' task was to identify the type of event that was marked by a red frame. The speaker still described the event, but this description was in English with no evidential marker (e.g., *She lit the lamp*). Therefore, this linguistic content contained no information that could assist participants in tracking which events get marked. If pragmatic factors were responsible for the previous learnability data in Experiments 1 and 2, the same factors should again lead to a Reportative category advantage since the task still involved a manifest communicative intention (albeit one that was expressed through visual means).

5.1. Methods

5.1.1. Participants

We recruited 59 participants in total between the ages of 18 and 70. None of them had participated in our earlier studies. All participants were native speakers of English and were recruited through Amazon Mechanical Turk. None of the participants reported knowing a language that has grammatical evidentials.

5.1.2. Stimuli and Procedure

The stimuli and procedure were the same as in Experiment 1 but the speech bubble contained the description of the event in English with no evidential marker. In the Training Phase, for videos where *ga* would have been uttered, a red frame appeared around the events for the complete duration of the video. The instructions that participants received in the Training Phase were the following (changes from Experiment 1 are marked in bold font):

> "You will watch a series of short clips involving three characters: in each clip, one character will perform an action on some object(s) and then put the objects away. A second character will learn about this action in different ways depending on what a third character does. **Some of the events will have a red frame. You will have to pay attention to when the red frame appears in order to try and figure out what kind of event gets this frame**. **After this, we will show you two new series of events to see whether you figured out what kind of event gets a red frame**."

For the Production Task, participants had to indicate whether a frame should accompany each event within a new set of videos. The instructions were as follows:

> "We will now show you a new series of clips. Here you will be asked to indicate which events get a frame and which ones do not. Almost everything will be the same as before BUT this time no

> frame is included. For each event, please type "Frame" if you think that the event should have a red frame or "No frame" if you think that no frame is needed."

In the Comprehension Task, participants watched a set of videos, in half of which the frame appeared for the correct Access type while in the remaining half, the frame either marked the wrong Access type or was missing for the relevant Access type. Participants were asked to type in 'Yes' or 'No', depending on whether the frame was included or omitted correctly. The instructions were as follows:

> "We will now show you a third series of clips. Almost everything will be the same as before. BUT this time, some events will have a red frame when it is not appropriate, or some events will be missing the red frame when it is needed.
>
> For each event, please type "Yes" or "No" in the textbox provided for each event to indicate whether the presence or absence of the red frame is correct."

At the end of the session, participants were asked when the red frame was used and what it could mean.

5.2. Results

Participants' responses were coded for accuracy. The summary results for each task can be seen in Figure 4. Separately for each task, a mixed-effects logistic regression model was used, including Accuracy as the dependent, binomial variable, and Evidential System as the fixed predictor along with random intercepts for Participants and Items (Table 4). Starting with the Production task, the fixed predictor System did not significantly improve the model fit based on a chi- square test of the change in -2 restricted log likelihood (χ^2 = 1.90, *p* = .16). Even though numerically there was a trend similar to the pattern observed for Experiments 1 and 2, with participants' accuracy for the Reportative System being higher than that of the Visual System (M_{Rep} = 0.89, M_{Vis} = 0.66), this difference did not reach significance - possibly because of the variance observed in participants' responses. Turning to the Comprehension task, the factor System did improve model fit (χ^2 = 7.54, *p* = .006), with participants showing higher accuracy for the Reportative than the Visual System (M_{Rep} = 0.90, M_{Vis} = 0.68).

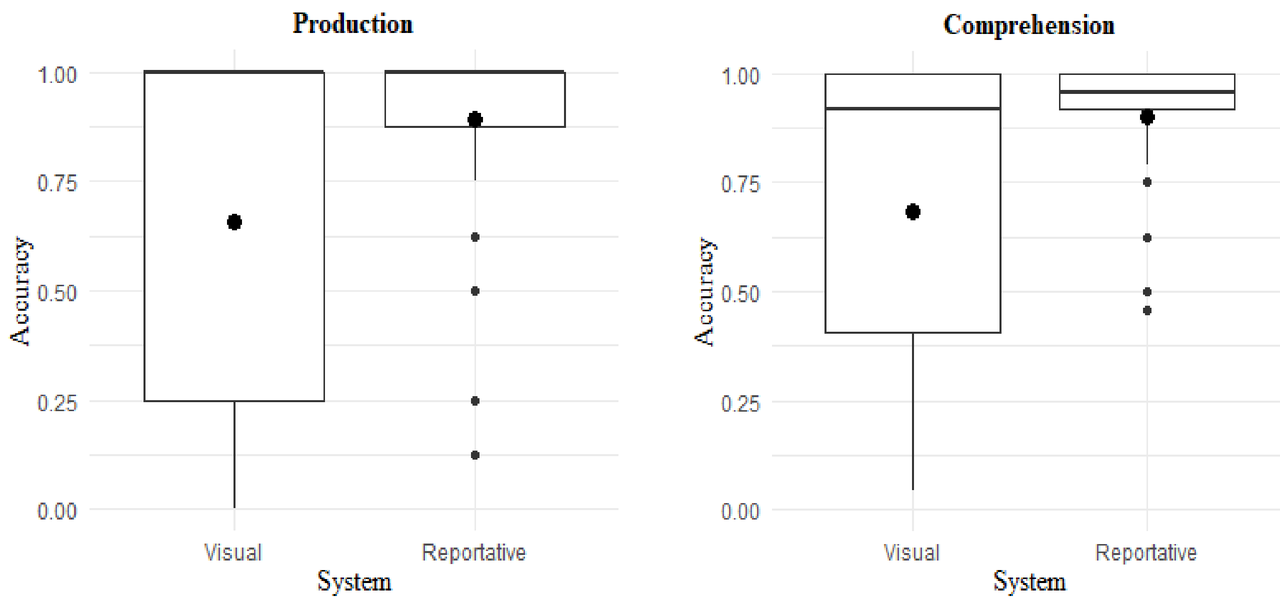

Figure 4. Accuracy score distribution, median (horizontal bar) and mean (dot) in Experiment 3.

Table 4. Parameter estimates for Accuracy in Experiment 3. Significance levels: * p < .05, ** p < .01, *** p < .001

Effects	Estimate	SE	z
Production Task			
Intercept	6.63	3.57	1.85
System (Reportative vs. Visual)	-2.50	2.70	-0.92
Comprehension Task			
Intercept	2.91	0.40	7.15 ***
System (Reportative vs. Visual)	-2.07	0.73	-2.79 **

The debriefing data provide additional insight into how the frame was interpreted. Of the 27 participants exposed to the Visual System, 12 correctly associated the presence of the frame with the main character's visual access to what happened: 9 of those participants associated the frame with the Speaker watching the event and 3 specifically mentioned that the character "wasn't blinded by the other girl" or "her eyes are not covered". The remaining 15 participants gave erroneous answers, either associating the frame with the opposite (Reportative) access (n = 7) or giving irrelevant responses (n = 8). Turning to the 32 participants that were exposed to the Reportative System, 26 gave correct responses, mentioning that the speaker had her eyes covered (n=10) or the speaker had her eyes covered and the third character told her what happened (n=16). The remaining participants (n=6) did not provide any evidential conjectures.

Lastly, we compared the results obtained from Experiments 1 and 3 to see whether the learnability patterns differed depending on whether participants tracked linguistic or non-linguistic ways of marking information sources. We ran a mixed-effects logistic regression model for each task (Production and Comprehension) using System (Reportative, Visual) and Experiment (1 vs. 3) as our fixed predictors with Accuracy as our dependent variable. Additionally, our models included random intercepts for Items and Participants. Overall results and parameter estimates for each task can be seen in Table 5. For Production, both System (Reportative, Visual) ($\chi^2 = 16.70, p < .0001$) and Experiment (1, 3) ($\chi^2 = 5.06, p = .02$) significantly improved model fit but the interaction between System and Experiment did not ($\chi^2 = 0.40, p = .52$). These results suggest that participants performed better when exposed to the Reportative System across both experiments ($M_{Rep} = 0.85$, $M_{Vis} = 0.63$), and when the target information source was marked with a non-linguistic Frame compared to an Artificial Language marker ($M_{Exp1} = 0.70$, $M_{Exp3} = 0.77$). For Comprehension, only the System factor improved the model fit ($\chi^2 = 22.87, p < .0001$); there was no significant effect for the factor Experiment ($\chi^2 = 1.05, p = .30$), nor for the interaction of System and Experiment ($\chi^2 = 1.25, p = .20$).

Table 5. Parameter estimates for Accuracy in the Production and Comprehension tasks of Experiments 1 and 3. Significance levels: ** p < .01, *** p < .001

Effects	Estimate	SE	z	
Production Task				
Intercept	2.14	0.29	7.30	***
System (Reportative vs. Visual)	-2.08	0.50	-4.11	***
Experiment (1 vs. 3)	1.14	0.50	2.82	*
System* Experiment	-0.78	0.97	-0.80	
Comprehension Task				
Intercept	2.78	0.33	8.43	***
System (Reportative vs. Visual)	-2.86	0.59	-4.83	***
Experiment (1 vs. 3)	0.49	0.57	0.86	
System* Experiment	1.45	1.16	1.25	

5.3.Discussion

Experiment 3 revealed a learnability pattern strongly resembling that of Experiment 1: participants were more accurate in learning to associate a frame with a character's Reportative access compared to Visual access when they had to judge the appropriateness of the frame that was given for a character's Reportative or Visual access to an event (Comprehension task). When participants needed to specify themselves which events should be marked by the frame (Production task), we got a numerical asymmetry in the same direction that was not, however, statistically significant. Importantly, as in Experiment 1, despite its ubiquity and naturalness as a conceptual category, visual experience was not preferentially marked as an information source even when marked through visual (and not verbal/morphological) means. This general pattern of results is consistent with a pragmatic account of the learnability of evidential distinctions.

How should we explain the precise shape of the current Production results? Notice that, for the Production task, participants had to indicate the presence or absence of a target category by actively choosing whether a frame should be inserted or omitted. This step involved adopting a different perspective on the event compared to the character in the videos who gained access to the event (and later talked about it). It is possible that the perspective switch was responsible for the noisier Production data in Experiment 3 and the fact that performance on this task was lower compared to its linguistic version in Experiment 1 (where only the speaker's perspective had to be tracked and adopted by the participant). In support of this line of reasoning, the Comprehension task that involved no such perspective shift yielded less noisy data (and performance was similar to Experiment 1).

6. Experiment 4

An alternative explanation for the current results is that the advantage of the Reportative system might be due to properties of the corresponding videos. For instance, the ease with which people learned to associate *ga* (or the red frame) with Reportative as opposed to Visual Access could be due to the fact that there was an 'extra' action in the Reportative videos, i.e., the third character whispering to the speaker. Additionally, or alternatively, one could argue that the third character's action of covering the speaker's eyes, even though present in both Access versions of the videos, was more salient in the Reportative Access videos because it occurred later and lasted as long as the main action. In Experiment 4, we sought to rule out this type of alternative explanation. We replicated Experiment 1 but exposed participants to sequences of 3 images from the original videos along with a sentence that jointly depicted the same access scenarios as in Experiment 1. However, now (a) the whispering action was depicted in only one of the three images in the Reportative case and was replaced with a seeing action in one of the three images of the Visual cases (such that it was not an 'extra' component); (b) the 'eye covering' action was always the first of the three images regardless of Access type and so was equally salient; (c) in addition to the visual stimulus, the type of access was always described with a sentence to further ensure that access was made equally available as a candidate for later encoding; (d) we named two of the characters in each event (Agent and speaker) and told participants from the outset that the story was about them to further background the third (whispering/eye covering) person.

If the results so far are due to a salient surface property of the Reportative Access videos and the absence of this property from the Visual Access videos, there is no reason to expect them to carry over to the non-video materials in Experiment 4. But if the previous results are due to the pragmatic naturalness of encoding only one of the two Access types, the new version in Experiment 4 should lead to similar results as our earlier experiments.

6.1. Methods

6.1.1. Participants

We recruited 72 participants between the ages of 18 and 70. All were native speakers of English with no prior exposure to a language that contains grammatical evidentials. All participants were recruited through Amazon Mechanical Turk and none of them had participated in our earlier studies.

6.1.2. Stimuli and Procedure

Stimuli and procedure were similar to Experiment 1 with some changes noted below. In the beginning of the experiment we named the speaker ('Ygritte') and the Agent ('Cora'). Specifically, participants were told:

> "Meet Ygritte and Cora! [individual pictures and names are shown] You will go through a series of short stories involving Ygritte and Cora! At the end of each story, Ygritte will describe what happened. Ygritte will be speaking an alien language. This language shares some words with English but it is different in several ways."

The rest of the task instructions were identical to those of Experiment 1, asking participants to "pay attention to when Ygritte uses 'ga' and try to figure out what it means".

The stimuli consisted of events, each displayed through a set of three pictures extracted from the videos used in Experiment 1. An example of an event can be seen in Figure 5. For Visual Access, in the first picture the speaker's eyes were covered (Panel A1); in the second picture, the speaker saw the agent perform the target action (Panel A2); the third picture displayed the speaker describing the event (Panel 3). For Reportative Access, the first picture showed the speaker having her eyes covered while the event was unfolding (Panel A1); in the second picture, a third character was shown whispering to the speaker

(Panel A2); in the third and final picture, the speaker described the event (Panel 3). For all events across both Systems, the second picture was accompanied by a sentence describing the Speaker's access to the event in that picture (e.g., in Figure 5, "Ygritte sees Cora light the lamp" vs. "Ygritte is told that Cora lit the lamp").

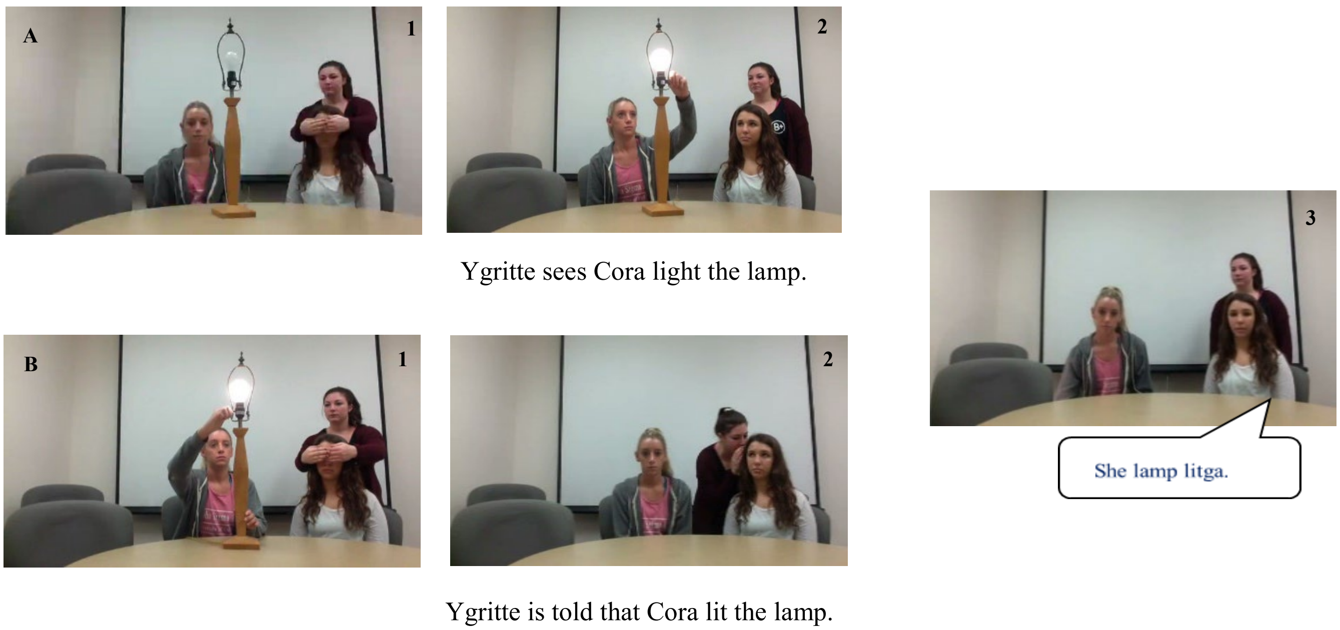

Figure 5. Sample trial from Experiment 4: in these pictures, a character ("Ygritte") gained access to an event either through visual access (A) or verbal report (B). The sentences that accompanied the pictures in A2 and B2 described the character's access to the event as depicted in that panel.

All other aspects of the design for the Training and Testing phase were identical to Experiment 1 (with only minor changes to the wording to refer to the character's names and the presence of pictures instead of videos). As before, participants were randomly assigned to either the Visual (n = 38) or the Reportative (n = 34) System.

6.2. Results

As in our previous experiments, participants' responses were coded for Accuracy for both the Production and Comprehension tasks. The summary results can be seen in Figure 7. A mixed-effects model was built for each task separately with participants' Accuracy as the dependent variable and System (Visual, Reportative) as the fixed predictor. Random intercepts for Participants and Items were also included in each model. We used contrast coding to compare the accuracy scores of the Reportative to those of the Visual System (-.50,.50).

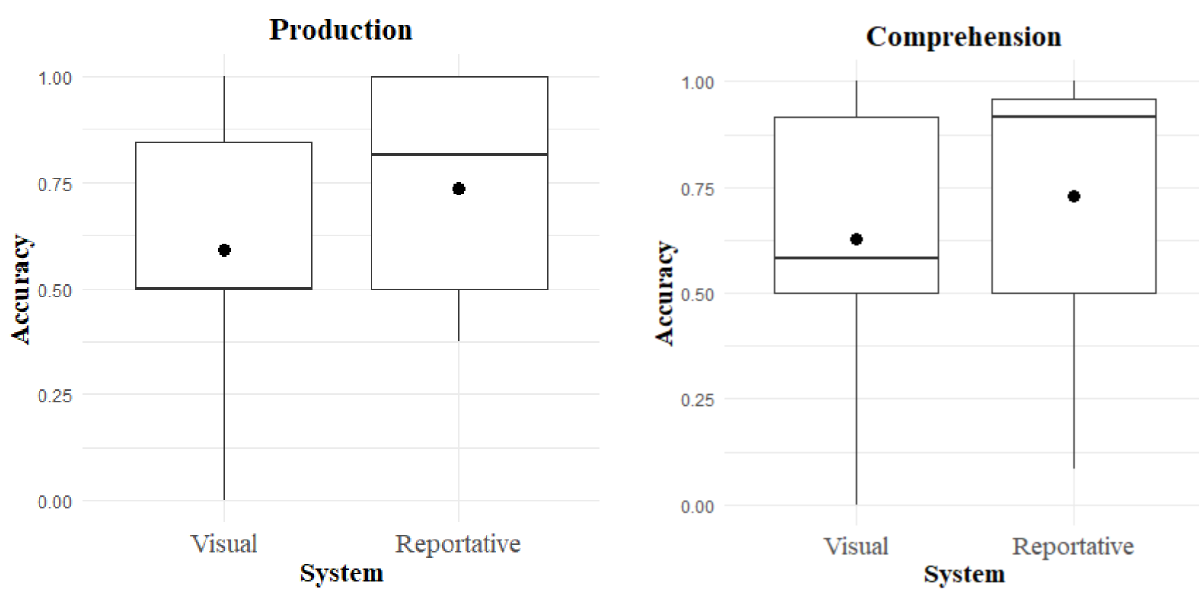

Figure 7. Accuracy score distribution, median (horizontal bar) and mean (dot) in Experiment 4.

For the Production task, the fixed predictor System significantly improved the model fit based on a chi- square test of the change in -2 restricted log likelihood (χ^2 = 4.92, p = .02). Participants showed higher accuracy rates for the Reportative compared to the Visual System (M_{Rep} = 0.73, M_{Vis} = 0.59). For the Comprehension task, the fixed predictor System also significantly improved the model fit based on a chi- square test of the change in -2 restricted log likelihood (χ^2 = 3.97, p = .04). There was again a learning advantage of the Reportative over the Visual System (M_{Rep} = 0.72, M_{Vis} = 0.62). The parameter estimates for each model can be found in Table 6.

Table 6. Parameter estimates for Accuracy in Experiment 4. Significance levels: * p < .05, ** p < .01, *** p < .001

Effects	Estimate	SE	Z
Production Task			
Intercept	0.99	0.21	4.70 ***
System (Reportative vs. Visual)	-0.88	0.39	-2.25 *
Comprehension Task			
Intercept	1.32	0.25	5.27 ***
System (Reportative vs. Visual)	-0.99	0.49	-2.01 *

Finally, we turn to participants' conjectures as to what each marker meant. Of the 38 participants exposed to the Visual System, 11 participants correctly connected the marker with the speaker witnessing the event. Three participants associated it with the *opposite* (i.e. Reportative) access type. An additional 13 participants connected the morpheme with grammatical meanings (e.g., past tense, definiteness/indefiniteness), and the rest provided irrelevant responses.

Of the 34 participants that were exposed to the Reportative System, 19 provided a correct evidential meaning by mentioning that the speaker "was told" or "heard" about the event (n = 16), or could not see/guessed (n = 3). One participant connected the marker with the *opposite* access type (i.e. Visual). An additional 10 participants associated the marker with grammatical meanings (past tense, definiteness/indefiniteness, singular/plural), and the rest hypothesized irrelevant meanings.

6.3. Discussion

In Experiment 4, we modified the design of Experiment 1 to address the possibility that surface features of the videos might have affected earlier learning outcomes. Our results replicated prior findings. We conclude that marking Reportative access to information is pragmatically privileged and therefore easier to acquire compared to marking Visual access when grammatical resources encode only one of these meanings. Strikingly, in Experiment 4, the asymmetry persisted even when both sources were verbally described in a sentence and therefore equally prominent (in addition to being depicted in the visual materials of our scenarios).

7. General Discussion

7.1. Pragmatics and the learnability of evidential systems

Within cognitive science it has often been assumed that highly frequent cross-linguistic semantic distinctions should be easier to learn than less frequent ones because they correspond to more natural concepts (e.g., TPH; Gentner & Bowerman, 2009). However, both the scope and potency of this generalization have remained unclear, and empirical work on the learnability of semantics has, in general, been limited (Xu et al., 2013; Carstensen et al., 2015; Maldonado & Culbertson, 2020; Saratsli et al., 2020). Here we explored an additional, or alternative, hypothesis, according to which learnability asymmetries (and the associated typological prevalence patterns) in some cases have pragmatic, as opposed to conceptual, origins.

We focused on evidentiality, since prior work comparing the learnability of multiple novel evidential systems has shown that systems encoding visual access to information – the least frequently marked information source cross-linguistically – are also the hardest to acquire by adult learners (Saratsli et al., 2020). Even though this finding confirms the hypothesis that cross-linguistic prevalence and learnability of semantic distinctions are linked, it presents a puzzle for the dominant view that attributes both prevalence and learnability to the conceptual naturalness of the underlying distinctions (e.g., Gentner & Bowerman, 2009) since visual perception is a concept available early in development and lexically expressed across different languages (Viberg, 1984; Pratt & Bryant, 1990; Ozturk & Papafragou, 2016; San Roque et al., 2018).

Across four experiments, we tested an alternative hypothesis on which the learning bias against visual evidentials is driven by pragmatic factors: learning to mark an indirect, potentially unreliable information source might be easier than learning to mark a source directly associated with perceptual experience and a lower likelihood to be false. In Experiment 1, we compared the ease of acquisition of two miniature evidential systems marking a single information source (Visual or Reportative) by adult native speakers of English whose language lacks obligatory grammatical morphemes encoding evidential distinctions. This very simple design removed some of the interpretive possibilities in prior, more complex Artificial Language Learning paradigms used to study the learnability of evidential systems (Saratsli et al., 2020). The pragmatic hypothesis predicted that, even within this very simple design, the Reportative should be the most learnable of the two systems. This prediction was borne out in our data. In Experiment 2, we replicated this paradigm but informed participants that the novel markers they were exposed to had evidential meanings. The pragmatic hypothesis predicted that, even when participants' conjectures were limited to the conceptual domain of evidentiality, pragmatic factors should still offer an advantage to the Reportative compared to the Visual system; again, this prediction was confirmed, with results largely replicating Experiment 1. In Experiment 3, we used the same paradigm except that the participants' task was to identify the kind of event that was marked by a red frame (the presence of the frame tracked either visual or reportative evidence within an event). The preference for the Reportative system persisted (albeit partially), thereby confirming the expectation that even if a speaker's information sources are selectively encoded in non-linguistic ways, reportative sources are still more marked. In Experiment 4, we showed that these learning patterns were not overturned when participants had to learn the morphemes from stimuli with different surface properties from those in earlier experiments.

Together our data offer evidence for the conclusion that highly frequent semantic distinctions are more learnable than less frequent ones (see Gentner & Bowerman, 2009; Saratsli et al., 2020; for similar results in syntax, phonology and morphology, see Christiansen, 2000; Newport & Aslin, 2004; Hudson Kam & Newport, 2005, 2009; Seidl & Buckley, 2005; Wilson, 2006; Thompson & Newport, 2007; Wonnacott et al., 2008; Finley & Badecker, 2008; Tily et al., 2011; Merkx et al., 2011; Culbertson, 2012; Culbertson & Smolensky, 2012; Culbertson et al., 2012; Fedzechkina et al., 2012; Tabullo et al., 2012). Most importantly for present purposes, our data support the assumption that both learnability biases in the semantic domain and the typological frequency of the corresponding semantic distinctions may in some cases have pragmatic – as opposed to conceptual - roots.[1]

Specifically, these results suggest that non-perceptual sources in our data are selectively marked in systems that have a single evidential morpheme because they are informative, i.e., they represent a departure from the primacy of perception as an information source (Grice, 1989; Barnard, Rosen & Matthews, 2017). First-hand information that derives from visual experience is reliable enough to make marking this type of information source of no pragmatic (i.e., communicative) value and hence, more difficult to learn. This is because visual perception as an information source is considered to be in direct correspondence with reality and to have a privileged status as a way of accessing information (Dancy, 1985; Papafragou et al., 2007; Matsui & Fitneva, 2009; Aikhenvald, 2018a; Wiemer, 2018). In contrast,

[1] The present results connect to the topic of markedness in grammatical paradigms (for overviews, see Gaeta, 2017; Batistella, 1996). In many of the common systems for grammatical categories (e.g., agreement or case), many members of the paradigm are marked with overt morphemes, but one type is absent/null. In many frameworks, that lack of marking is still marking, because it is in opposition to the overt markers and has an interpretation (i.e., it is represented in the syntax). Even though participants in our task were only instructed to attend to the meaning of an overt morpheme, one possible construal of our results is that participants prefer a system where indirect marking is overt/marked and direct marking is null/unmarked. If so, participants who learn the indirect marker as such also learn something about the unmarked counterpart.

indirect information sources, with reported information being the most indirect source category, are generally less reliable, as they diverge from one's perceptual experience and call for the employment of epistemic vigilance (Sperber et al., 2010). As a result, marking those sources can signify doubt and lack of direct evidence for an event, a pragmatically noteworthy property in communication (Speas, 2018; Wiemer, 2018).

Our data have implications for the way children learn evidential systems. Prior studies indicate that the acquisition of evidentiality is challenging cross-linguistically (Aksu-Koç, 1988; Lee & Law, 2000; Aksu-Koç & Alici, 2000; Matsui, Miura & McCagg, 2006; Matsui, Yamamoto & McCagg, 2006; Papafragou et al., 2007; Aksu-Koç, Ögel-Balaban & Alp, 2009; de Villiers, Garfield, Gernet-Girard, Roeper & Speas, 2009; Winans, Hyams, Rett & Kalin, 2014; Ozturk & Papafragou, 2016; Ünal & Papafragou, 2016; Uzundag, Taşçı, Küntay & Aksu-Koç, 2018; Fitneva, 2008, 2018; Avcılar & Ünal, 2022). These studies have often hypothesized that part of the difficulty in acquiring evidential distinctions lies in the subtle and abstract conceptual presuppositions of evidential meanings. The present data suggest that, independently of conceptual issues, the acquisition of a single evidential poses *pragmatic* issues for the learner.

An interesting question is whether – as we predict - learners treat linguistic markers of visual access asymmetrically compared to other information sources. Even though some studies suggest that children produce the direct evidential earlier than the indirect evidential in Turkish and other languages where both are marked morphologically (e.g., Aksu-Koç, 1988), there is rampant cross-linguistic evidence that young children overextend the direct evidential (on Turkish, see Ozturk & Papafragou, 2016; on Tibetan, see de Villiers et al., 2009). These overextension patterns indicate that the direct evidential is used for a period without a true evidential meaning; for instance, in Turkish, where evidential morphemes also encode past tense, the direct evidential is used as the default past tense (Ozturk

& Papafragou, 2016). In accordance with our present hypothesis, no such overextensions are reported for indirect evidentials (ibid.).

Related findings on encoding indirect vs. direct evidence come from bilingualism. An eye tracking study by Arslan, Bastiaanse and Felser (2015) asked how adult early and late Turkish-German bilingual speakers, as well as monolingual speakers of Turkish, understand grammatical evidentiality in a visual world setting that involved access to different types of evidence. It was found that monolingual speakers comprehended direct and indirect evidential forms equally well. In contrast, both late and early bilinguals were less accurate and slower to respond to direct than to indirect evidentials; these difficulties were also reflected in eye gaze data. The authors summarized their findings by stating: "[…] both early and late bilinguals were more accurate and quicker to respond to the more marked term (the indirect evidential) here, whose use is licensed only by the availability of a specific type of evidence, than to the less marked term (the direct evidential)." They proposed that the grammar of evidentiality had undergone change in these bilinguals, perhaps because bilingual participants took the direct evidential to be a past tense marker without any specific evidential content but retained the indirect evidential as an evidential form associated with reporting non-witnessed events (Arslan et al., 2015; cf. also Arslan, de Kok & Bastiaanse, 2017).

Evidence from language production corroborates this pattern: Arslan and Bastiaanse (2014) report that early Turkish-Dutch bilingual speakers mistakenly produced direct evidential forms in contexts where an indirect evidential would normally be required in Turkish, thereby ignoring the evidential content of direct evidential forms; the opposite substitution error did not occur. Furthermore, in Turkish speakers with agrammatic Broca's aphasia, the direct evidential was found to be more affected during production compared to the indirect evidential, even though the ability to identify the source for directly perceived events was retained (Arslan, Aksu-Koç, Maviş & Bastiaanse, 2014). Together these studies support the conclusion that the direct evidential has a more vulnerable semantic-pragmatic status compared to the indirect evidential, and as a result this status is more likely to shift during language learning and language disorder (see also next section).[2]

Future work needs to address directly the issue of how these patterns might be related to pragmatic reliability. We know that children realize that, other things being equal, visual perception is a highly reliable information source (Pillow, 1989; Pratt & Bryant, 1990; Robinson, Champion & Mitchell, 1999; Clément, Koenig & Harris, 2004; Robinson, Haigh & Nurmsoo, 2008; Ozturk & Papafragou, 2016); moreover, young children prefer interacting with and learning from reliable rather than unreliable speakers (Sabbagh & Baldwin, 2001; Koenig & Harris, 2005; Jaswal & Neely, 2006; Mascaro & Sperber, 2009; Koenig, 2012; Jaswal, 2010; Fusaro, Corriveau & Harris, 2011; Harris, 2012). Furthermore, we know that adults at least are sensitive to the epistemic meaning of information source marking (e.g., they recognize that indirect sources of information convey uncertainty or reduced reliability; Arslan, 2020; Degen et al., 2019). It remains to be seen how these considerations shape leaners' hypotheses about the meaning of unknown evidentials.

7.2. *Pragmatic vs. conceptual naturalness and the learnability of semantics*

Taken most broadly, our data show that certain semantic distinctions are easier to learn (and more prevalent across different languages) not because of the naturalness of the expressed meanings but because of their communicative contribution. On this picture, pragmatic pressures can be viewed as one of the many factors that learners of any age use to map otherwise available concepts onto linguistic forms in their input (Gleitman, 1990). Because pragmatic pressures such as the need to be informative are

[2] In anecdotal evidence, speakers of Turkic and other languages notice the absence of a non-firsthand verb form when speaking English (Friedman, 2003, p. 210), and sometimes bilingual speakers of languages with obligatory evidentials import hearsay markers from their language or overuse "they say" when speaking English to one another (Aikhenvald, 2018, p.167). No mention of an evidential gap in bilinguals for direct/firsthand evidentials is made in either paper. Similarly, in an overview of how evidential systems change across several languages, including in language contact situations, examples of new evidentials mostly involve either systems of encoding both direct and indirect evidence or indirect (reportative) evidentials alone (Aikhenvald, 2018).

presumably universal (Grice, 1975; Sperber & Wilson, 1986), they can capture robust and cross-linguistically stable features of both the shape and acquisition of semantic distinctions. This perspective comports with evidence showing that, early on in life, humans selectively comment on whatever they find unexpected and hence informative (Greenfield & Smith, 1976; Greenfield, 1979), and even young children calculate informativeness as they learn and use language (Bannard et al., 2017; Grigoroglou & Papafragou, 2019a, b; Kampa & Papafragou, 2020; Katsos & Bishop, 2011; Frank & Goodman, 2014).

The present perspective generalizes to several other domains beyond evidentiality. For instance, within the spatial domain, there are well-documented and cross-linguistically robust differences in vocabulary learning: spatial terms roughly equivalent to *in, on, under* seem to be acquired earlier than *back* and *front*, while other terms appear even later (Johnston & Slobin, 1979). These learnability differences have traditionally been attributed to conceptual asymmetries (e.g., the basicness of simple topological concepts encoded by *in, on, under* compared to the complexity of projective concepts such as *front/back* that require the calculation of axial information (ibid.). Within the projective class, further conceptual asymmetries have been invoked to explain why *back* appears early in child speech and is used more frequently than *front* (Johnston & Slobin,1979). In contrast to this simple conceptual hypothesis, a wealth of experimental evidence points towards a more complex picture of the acquisition of spatial semantic terms that is sensitive to the multiplicity of options for encoding semantic relations (e.g., Landau et al., 2010). Importantly for present purposes, the strive for informativeness often seems to be at the heart of such cross-linguistic patterns. For instance, even adults prefer to use *back* more frequently than *front* cross-linguistically, and the reasons seem to be related to the informational gains from using *X is to the back of Y* to locate what are typically occluded objects (Grigoroglou, Johanson & Papafragou, 2019). Many other asymmetries in the use and acquisition of spatial prepositions can also be attributed, at least in part, to pragmatic (informativeness) effects (see, e.g., Do, Papafragou & Trueswell, 2020 on the source/goal asymmetry in motion events).

A second example comes from mental verbs such as *think, believe* and *know*. Such verbs have traditionally been considered hard to acquire because the underlying abstract concepts are hard to grasp (Huttenlocher, Smiley & Charney, 1983). Yet, in a set of findings highly reminiscent of the present work, Papafragou, Cassidy and Gleitman (2007) showed that both young children and adults interpret novel verbs as mental verbs when they were presented with a story in which the verbs described *false* beliefs. For instance, if a story involved deception similarly to the classic Red Riding Hood tale, the novel verb in a sentence such as "Matt gorps that his grandmother is under the covers", was more likely to be interpreted as a mental verb (e.g., *think* or *know*) by both young and more experienced (adult) learners compared to a story where Matt's belief was true. Thus, talking about beliefs was expected when these beliefs did not correspond to reality and hence presented a pragmatically notable property (cf. also Hacquard & Lidz, 2019). Similarly, in our current findings, perceptually supported (and presumably true) beliefs were less likely to be highlighted compared to indirectly acquired (and potentially false) beliefs.

Most generally, our proposal is compatible with evidence pointing to the centrality of pragmatics in language acquisition (for reviews, see Grigoroglou & Papafragou, 2017, 2021; Clark & Amaral, 2010; Matthews, 2014). We know that children's acquisition and use of words in several semantic domains including modals (Ozturk & Papafragou, 2015), aspectuals (Papafragou, 2006; Wagner, 2009), quantifiers (Noveck, 2001; Papafragou & Musolino, 2003; Lidz & Musolino, 2006), gradable adjectives (Syrett, Kennedy & Lidz, 2009), numbers (Musolino, 2004; Barner & Bachrach, 2010), negation (Nordmeyer & Frank, 2014; Reuter, Feiman & Snedeker, 2018), mass/count terms (Srinivasan & Barner, 2016), and color vocabulary (Wagner, Tillman & Barner, 2016), is a function not just of the semantic content of these words (and hence the underlying concepts) but also of their pragmatics. In many of these areas, children seem to acquire new members of the lexicon by making conjectures about new meanings on the basis of contrasts with existing words in the language (see E. Clark, 2010, for a classic formulation of this idea). As in our own experiments, many hypotheses about what a linguistic expression encodes rest on comparisons to other lexical alternatives (or to the absence thereof).

Beyond the developmental field, the present proposal has affinities with research exploring the role of pragmatics in shaping the adult lexicon. For instance, it has been suggested that languages lack words for meanings that are canonically conveyed by stable and ubiquitous pragmatic implicatures (e.g., cross-linguistically, there is no quantifier meaning ‘not all’, presumably because the same meaning is a strong pragmatic inference from the use of *some*; Horn, 1989). This direction has recently led to computational approaches that have linked the organization of the lexicon cross-linguistically to communicative pressures related to efficiency (Gibson et al., 2017; Kemp, Xu & Regier, 2018). This idea of efficiency highlights the fact that language, as a vessel for communication, needs to be both maximally informative but also simple: the intended message should contain all the essential information needed to fully understand what is being communicated but this needs to happen using minimal cognitive resources (Regier, Kemp & Kay, 2015; Regier, Carstensen & Kemp, 2016; Gibson et al., 2019; Steinert-Threskeld & Szymanik, 2020).

Finally, it is important to consider the mechanisms by which pragmatic factors might lead to attested typological biases. One possibility is that the creation and loss of new markers/constructions that over time leads to language change and shapes cross-linguistic patterns is driven by child learners (for a similar perspective, see Cournane, 2014; Lightfoot, 2017; Roberts & Roussou, 2003; Van Gelderen, 2004; and in a different context, Hudson Kam & Newport, 2009). In the case of evidentiality, the morphological typology might favor indirect over direct source marking cross-linguistically because it is easier for young learners to create the more common morphemes (e.g., by innovating useful hearsay or inferential markers from verbs or aspectual morphemes), and/or lose the less common ones (e.g., by omitting or reanalyzing direct markers because they lack communicative value). This possibility is strongly supported by the loss of sensitivity to the semantic and pragmatic function of direct (but not indirect) evidential forms in bilingual speakers and agrammatic aphasic populations (Arslan et al., 2015; Arslan et al., 2017; Arslan & Bastiaanse, 2014): in such cases, as alluded to earlier, the direct evidential becomes the target of learner-driven language change or loss. It is also compatible with the fact that, among the many innovations languages make to express indirect sources (Aikhenvald, 2018b), some are known to be pioneered by young language users (e.g., the quotative *be like* was embraced first by teenage girls; Tagliamonte & D'Arcy, 2004). An alternative, or additional, possibility is that adults are plausible sources of change: in languages with richer grammaticalized evidential systems, for instance, the direct evidence markers might be less used and less useful (for input speakers), and so children might not learn them as a result of such limited exposure.

7.3. Final remarks

Our study provided evidence that the learnability of semantic distinctions is linked to the typological frequency of these distinctions and proposed that the learnability patterns can have a pragmatic motivation. We take this proposal as a promising framework for understanding how foundational pragmatic factors shape the acquisition of semantics in ways that complement the more heavily studied conceptual factors underpinning language structure and acquisition. How to disentangle the contributions of conceptual from pragmatic (and other mapping) factors to the acquisition process is an exciting direction for future work.

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Appendix A

List of events used in all experiments

Events			
1	She squeezed the toothpaste.	**22**	She cracked the peanut.
2	She sorted the markers.	**23**	She strung the beads.
3	She bit the apple.	**24**	She shoveled the dirt.
4	She flipped the pans.	**25**	She separated the plates.
5	She wound the yarn.	**26**	She aligned the animals.
6	She rotated the vase.	**27**	She drew the square.
7	She chopped the celery.	**28**	She deflated the balloon.
8	She lit the lamp.	**29**	She popped the coughdrops.
9	She hung the hanger.	**30**	She stapled the packet.
10	She mixed the gumballs.	**31**	She connected the dots.
11	She circled the word.	**32**	She emptied the pouch.
12	She packaged the foam.	**33**	She arranged the blocks.
13	She closed the book.	**34**	She matched the socks.
14	She layered the stickers.	**35**	She removed the letter.
15	She pasted the photos.	**36**	She braided the string.
16	She unfurled the umbrella.	**37**	She gathered the flowers.
17	She flattened the putty.	**38**	She stacked the cups.
18	She suspended the curtains.	**39**	She sliced the bread.
19	She clipped the sheets.	**40**	She unpacked the bookbag.
20	She folded the towel.	**41**	She unbuttoned the sweater.
21	She colored the star.	**42**	She split the cracker.