



HAL
open science

When the owner of information is unsure: Epistemic uncertainty influences evidentiality processing in Turkish

Seçkin Arslan

► **To cite this version:**

Seçkin Arslan. When the owner of information is unsure: Epistemic uncertainty influences evidentiality processing in Turkish. *Lingua*, 2020, 247, pp.102989. 10.1016/j.lingua.2020.102989 . hal-02989149

HAL Id: hal-02989149

<https://hal.science/hal-02989149>

Submitted on 7 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

processing in Turkish When the owner of information is unsure: Epistemic uncertainty influences evidentiality

Seçkin Arslan

University of Groningen, Faculty of Arts, Groningen, The Netherlands & Université Côte d'Azur, CNRS, BCL, France

*Correspondence: Dr. Seçkin Arslan,
Faculty of Arts, Neurolinguistics
Harmoniebuilding, PO Box 716
9700 AS Groningen, The Netherlands
+31503636038
seckin.arslan@rug.nl seckin1984@gmail.com

ORCID <https://orcid.org/0000-0001-9330-1619>

Acknowledgements

This study was supported by the Academy of Korean Studies [research grant no. AKS-2019-R22], and Seckin Arslan has been supported at different phases during preparation of this study by funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie [grant agreement no. 838602], and by the Agence Nationale de la Recherche and Université Côte d'Azur under a young researcher award as a part of the Initiative of Excellence scheme (ANR-15-IDEX-01).

Abstract

This study deals with the extent to which epistemic uncertainty influences processing of grammatical evidentiality –the linguistic reference to information source– in Turkish native speakers. Across a series of sentence reading experiments administered to groups of Turkish adult native speakers, this study showed that indirect evidentiality in firsthand witnessing contexts evoked greater post-interpretive disruptions (Experiment 1), and were found largely unfavourable (Experiment 2), suggesting that in Turkish, speaking about one’s own information with indirect evidentiality leads to an inherent effect. Furthermore, a first-person’s witnessed information marked with direct evidentiality is found to be rather unacceptable or unsettling under low epistemic certainty conditions, where the speaker is unsure of his/her own witnessing (Experiment 3), whilst a non-first-person’s information blends well with uncertainty constraints for which, Turkish readers strongly favour the assumption marker (Experiment 4). This study indicates that Turkish speakers’ sensitivity to uses of evidentiality is influenced by the ‘uncertainty of information owner’. There is a semantic overlap and a complex interface between evidentiality and epistemic modality in Turkish, and this interface is mediated by the ownership of information (first-person versus non-first-person) and the owner’s uncertainty about his/her information. Further implications are discussed.

Keywords: evidentiality, epistemic modality, uncertainty, Turkish, sentence comprehension

1 **1. Introduction**

2 Evidentiality refers to the linguistic marking of the types of information sources a speaker has
3 access to for the event being referred to in one's statement (see, e.g., Aikhenvald 2004, Lazard
4 2001, Willett 1988, Plungian 2001, Aikhenvald 2003, Johanson and Utas 2000). Information
5 sources encoded in grammar can be first-hand sources, such as one's own witnessing, or
6 second-hand sources, including reports from other speakers. This paper addresses the
7 interface of evidentiality and epistemic certainty. Consider the choice of modal verbs and
8 adverbs in English: "*Probably it might/may/will rain tomorrow afternoon.*" The certainty of a
9 state can be expressed via lexical adverbs (e.g., 'probably') or through grammaticalized
10 modal verbs (e.g., 'might') and affixes. Epistemically modal expressions are framed under
11 'epistemic modality', which involves the speaker's evaluation or attitude to the likelihood that
12 an event or state might occur (Nuyts 2001a, Halliday 1970, Palmer 2001, Papafragou 2006,
13 Lyons 1977).

14 Whether or not evidentiality is a part of epistemic modality system is a long-standing
15 debate. While the earlier linguistic analyses considered evidentiality under epistemic modality
16 (Palmer 2001, Chafe and Nichols 1986, Givón 1982, Willett 1988), some others argued that
17 evidentials are best characterized as an independent grammatical category (e.g., Aikhenvald
18 2004, De Haan 1999, Plungian 2001, De Haan 2005; see Boye, 2010 for a discussion).
19 Although the latter account does not oppose the idea that the grammatical marking of
20 evidentiality may lead to epistemic connotations, both the categories seem to semantically
21 overlap to differing degrees (see Nuyts 2001b, Cornillie 2009, Faller 2002, Van der Auwera
22 and Plungian 1998). For example, evidential forms may inherently mark the speaker's
23 epistemic attitude (Dendale and Tasmowski 2001, Plungian 2001, Fitneva 2001). The current
24 study's aim is to test to what extent speakers of Turkish – a language that marks evidentiality
25 obligatorily in its verb inflection system – are sensitive to the speaker's certainty manipulated
26 with epistemically modal predicates during their processing of evidentiality.

27 Research on nonevidential languages (i.e., languages where evidentiality is not
28 grammaticalized), such as English, has shown that an epistemic state expressed in sentence
29 material affects the sentence processing. This is framed in Clifton and Frazier’s Epistemic
30 State Hypothesis (ESH; Clifton and Frazier 2016, 2018), which holds that comprehenders are
31 sensitive to the epistemic state of the speaker. Using a series of offline questionnaires and
32 eye-tracking-during-reading experiments, Clifton and Frazier (2016) examined English
33 speakers’ sensitivity to (dis)conjunctive noun phrases (i.e., John or Bill left. Sam did too. vs.
34 John and Bill left. Sam did too.). Their data showed that those sentence materials connected
35 with ‘or’ were found to be more unnatural and processed with increased difficulty than when
36 they were connected with ‘and’. The authors suggest that skilled readers found sentence
37 materials with an unusual epistemic state rather unnatural, particularly when the speaker
38 being referred to in the proposition had access to partial knowledge regarding an event.
39 Clifton and Frazier (2018), in their Experiment 5, explored the possible effects of the
40 epistemic state on sentence processing using sentence material where the event expressed in
41 the proposition has happened or will happen (i.e., ‘Jeff objected/will object to the new policy
42 *or/and* decline/declined to support it’). They found that disjoint clauses (i.e., using ‘or’) with
43 future tense were more frequently preferred than when the sentence used past tense,
44 suggesting that the epistemic uncertainty expressed in future tense blends well with
45 disjunction.

46 Research has evidenced that English speaking children’s understanding of differing
47 degrees of epistemic stance (i.e., certainty, possibility or necessity) borne out in modal
48 expressions is correlated with children’s understanding of beliefs (e.g., Moore, Pure, and
49 Furrow 1990, Öztürk and Papafragou 2015, Robinson and Whitcombe 2003). A set of
50 acquisition studies paid particular attention to whether and how children are able to monitor
51 the certainty/reliability of information using grammatical evidential forms as cues. Matsui,
52 Yamamoto, and McCagg (2006) investigated Japanese children’s (aged 3-6) ability to

53 distinguish sentences with the grammatical marking for direct evidence and reported the
54 results. The authors showed that Japanese children were able to use information in evidential
55 particles to understand speakers' epistemic certainty, although the children at these ages were
56 incapable of fully judging other's false beliefs. Papafragou et al. (2007) investigated groups of
57 Korean children (aged 3-4) and showed that children at young ages performed successfully on
58 tasks that require the production of reported and direct evidential forms and on nonverbal
59 source memory tasks, although their comprehension of the evidential forms and judgement of
60 the reliability of information sources were unstable at this stage. Fitneva (2008) examined
61 Bulgarian children's (aged 6-9) reliability monitoring for statements with evidential forms
62 using a design that required children to follow a conversational context including events that
63 occurred between two characters, and a third character in the story needed to decide who to
64 believe among the two. The children's task was to identify who the third character believed,
65 and the results showed that the children rely more on first-hand evidence available through
66 direct experience than second-hand evidence such as reported inferences (i.e., inferential
67 deductions made by another speaker) while monitoring the reliability of information.

68

69 **1.1. Evidentiality and epistemic certainty in Turkish**

70 Turkish –an *evidential language*– has two forms of grammatical evidentiality for referring to
71 sources of information, direct and indirect evidential information sources, as illustrated in (1)
72 and (2), respectively. To describe a past event, Turkish speakers are obliged to choose
73 between the direct and indirect evidential forms. That is, the evidential marking is not an
74 optional category. In (1), the direct evidential, encoded by the morpheme –DI, conveys that
75 the author/speaker has acquired the information regarding this event through directly
76 witnessing it. By contrast, in (2), the use of an indirect evidential, codified by the morpheme –
77 (I)mİş, expresses that the author/speaker has no access to a piece of direct information but has
78 learnt about this event through either the report of another speaker or via inference from some

79 observable evidence (Aksu-Koç and Slobin 1986, Aksu-Koç 2000, Slobin and Aksu 1982,
80 Yavaş, 1980).

81

82 (1) Nurhayat çok güzel bir şarkı söyle-di
83 Nurhayat very beautiful one song say-DIRECT EVID
84 ‘Nurhayat sang a very beautiful song’ [witnessed]

85

86 (2) Nurhayat çok güzel bir şarkı söyle-miş
87 Nurhayat very beautiful one song say-INDIRECT EVID
88 ‘Nurhayat sang a very beautiful song’ [non-witnessed, reported/inferred]

89

90 It is important to acknowledge that most studies in Turkish linguistics define the
91 indirect evidential as having two distinct functions. The inferential –miş signals that the
92 speaker has acquired the knowledge expressed in his/her statement through inference either
93 by making a logical deduction based on world knowledge or available prior knowledge or by
94 observing the resultant states of a finished action or state; the reportative –(I)mİş, however,
95 indicates that the speaker acquired knowledge on an event through the reports of another
96 speaker (see Csató, 2000 for an overview). When the indirect evidential form is marked on
97 bare verb stems, however, there is no clear morphological distinction between different
98 functions; hence, one needs contextual information to distinguish between reportative and
99 inferential functions.

100 In line with the standpoint of Palmer (2001, pp. 8), who asserted that ‘epistemic and
101 evidential systems are two types of propositional modality’, many scholars in Turkish
102 linguistics often regarded evidentiality as a modal system (see Erguvanlı-Taylan 1997, Uzun
103 1998 for discussions). Johanson (2000) postulates that the Turkish indirect evidential (–
104 (I)mİş) can be epistemic with regard to the expression of indirect experience, but it does not

105 convey the speaker's attitude regarding the truth of the propositional content. As previously
 106 stated, whether evidential marking in Turkish falls within the broader concept of epistemic
 107 modality or whether evidentials constitute their own grammatical category has been subject to
 108 debate (e.g., Aksu-Koç 2016, Boye 2010, Cornillie 2009, Aikhenvald 2004). Under either
 109 view, evidential marking in Turkish may lead to epistemic connotations that indicate
 110 uncertainty. In other words, evidentiality marking is confounded by the presence of epistemic
 111 connotations in Turkish since direct information stemming from one's own experience
 112 constitutes a more reliable source than indirect information based on the knowledge of others.
 113 Therefore, a more reliable information source conveyed through direct evidentiality often
 114 indicates greater certainty that the event expressed in the proposition has occurred than when
 115 that event is communicated in an utterance marked for indirect evidentiality (for arguments on
 116 this, see Lucas et al. 2013, Karaslaan et al. 2018).

117 Epistemic uncertainty is typically expressed using lexical adverbs in Turkish. For
 118 example, adverbs such as *belki* 'perhaps' and *herhalde* 'supposedly' have epistemic readings
 119 indicating the speaker's partial information or lack of certainty regarding whether the events
 120 expressed in the proposition have occurred or will occur, such as in (3). By contrast, adverbs
 121 including *mutlaka* 'surely' and *kesinlikle* 'absolutely' convey a high certainty of the speaker,
 122 such as in (4). Importantly, the epistemic uncertainty of the speaker can be expressed via verb
 123 semantics, and certain verbs denoting a degree of certainty (e.g., *sanmak* 'to assume/to think'
 124 and *emin olmak* 'to be certain') often function as modal predicates, such as in (5). See
 125 Kerimoğlu (2010) for a list of adverbs and verbal predicates that convey epistemic
 126 uncertainty.

127

128	(3) Şengül	belki	bizimle	konser-e	gel-ir
129	Şengül	perhaps	US-GEN-COMM	concert-DAT	come-AOR
130	'Perhaps Şengül comes to the concert with us'				

131

132

133 (4) Nihal kesinlikle beyaz şarap iç-er

134 Nihal absolutely white wine drink-AOR

135 ‘Nihal absolutely drinks white wine’

136

137 (5) Sevgi’-nin eşin-den boşan-acağ-ını san-ıyor-um

138 Sevgi-GEN spouse-ABL divorce- FUTPART-3SG-ACC assume-PRESPROG-1SG

139 ‘I assume that Sevgi is going to divorce her spouse’

140

141 The suffix *-Dir* marks the degrees of the epistemic certainty of the speaker and signals

142 that information about an event being uttered is based on the speakers’ logical deduction or

143 assumption (Göksel and Kerslake 2005, Kornfilt 2013), such as in (6). Additionally, the

144 habitual aspect ‘aorist’ marker (*-Ar*) is often used to express a number of connotations

145 affiliated with uncertainty including deduction, probabilistic analysis and speculation

146 depending on the context of use (Temürcü 2007), as shown in (7).

147

148 (6) Perihan ev-de dinlen-iyor-dur

149 Perihan home-LOC rest-PRESPROG-EPISTEMIC

150 ‘Perihan must be resting at home’

151

152 (7) Tülay bun-a çok üzül-ür

153 Tülay this-DAT very sadden-AOR

154 ‘Tülay will be very sad for this.’

155

156 Although studies on epistemic meanings in Turkish have been scarce, children's
157 acquisition of evidentiality is well established, and the previous studies indicated that young
158 Turkish children typically acquire direct evidential forms earlier than their indirect
159 counterparts from 2-3 years of age (see, e.g., Aksu-Koç, Ögel-Balaban, and Alp 2009, Öztürk
160 and Papafragou 2016, Aksu-Koç 1988, Uzundag et al. 2018). For instance, Öztürk and
161 Papafragou (2016) report on an examination of monolingual Turkish children (aged 5-7)
162 using elicited production, semantic/pragmatic comprehension and source memory tasks. The
163 authors showed that at young ages, children tend to overextend uses of the direct evidentials
164 to contexts that do not signal direct evidence, and their ability to distinguish the speakers'
165 choice of an indirect evidential may indicate that a *less reliable* information source develops
166 at around the age of 6. It should be noted that the direct evidential form appears to be
167 privileged over the indirect form in both linguistic and source memory tasks during children's
168 development (see Ünal and Papafragou 2018 for an overview). Acquiring evidential
169 morphology is challenging since it takes children a long time to have full control over their
170 evidentiality system, which also seems to apply to the adults studied under artificial language
171 learning circumstances (Saratsli, Bartell, and Papafragou 2020).

172 There is further emerging research focusing on the processes involved during the
173 interpretation of evidential forms using techniques to examine the per millisecond time course
174 of these processes in adult Turkish speakers (Arslan, Bastiaanse and Felser 2015, Arslan, de
175 Kok, and Bastiaanse 2017). Using the eye-tracking-during-listening paradigm, Arslan, et al.
176 (2015) found that a monolingual group of Turkish speakers had a greater number of fixations
177 towards the picture portraying an ongoing version of an action during their processing of the
178 direct evidential form, although they considered the finished version of the action to be
179 correct (since the direct evidential conveys a past time reference). These findings confirmed
180 that Turkish speakers need to witness an event to properly use a direct evidential. Arslan, et
181 al. (2017) used a sentence verification experiment to examine whether Turkish speakers are

182 sensitive to evidentiality–information source mismatches using sentence materials where the
183 owner of the information and marking for the evidential form are mismatched (e.g., *Yerken*
184 *gördüm/Yerken görmüşler, az önce adam yemeği yedi/yemiş** ‘I/They saw the man eating. He
185 ate the food DIRECT/INDIRECT*’)¹. The authors showed that monolingual Turkish speakers
186 present an asymmetric pattern in their sensitivity with faster responses to first-hand
187 information source–indirect evidential mismatches compared to non-first-hand information–
188 direct evidential mismatches, suggesting that the use of an indirect evidential in first-person
189 first-hand information context is rather more counterintuitive and native Turkish speakers
190 immediately notice these mismatches. See Arslan (2020) for a recent overview.

191

192 **1.2. Relevant studies on epistemic - evidentiality interface and the current study**

193 Aksu-Koç (2016) presents an interface model of evidentiality and epistemic modality,
194 building on Palmer’s (2001) framework where evidentiality is treated as an independent
195 modal category, with support from empirical data on Turkish children’s acquisition of
196 evidential and epistemic forms. The model addresses the indirect evidential form that marks
197 reportative and inferential readings (i.e., –mİş), and the assumption marker (–DİR). The first
198 line of data reported by Aksu-Koç, Ögel-Balaban, and Alp (2009) showed that 4- to 6-year-
199 old Turkish children encounter difficulties in identifying the sources of novel facts that they
200 acquired through the reports of others (see also Öztürk and Papafragou 2016). The second line
201 of data reported by Aksu-Koç and Alici (2000) was based on Turkish children’s (aged 3-6)

¹ Please note that the information source– evidential mismatches here do not constitute clear-cut ungrammaticality, but they do expose pragmatic effects that are often unsettling. These mismatches can intentionally be used under rather infrequent but meaningful contexts. For instance, a direct evidential in a non-first-hand context may be interpreted as consolidated information in which the validity of the event that occurred is well assumed, although the information has been received through a third-party source. By contrast, uses of indirect evidential in first-hand contexts, which suggest that the speaker has not directly acquired his/her own information, are rather unintuitive but can occasionally occur when one recounts a dream in which events are rather unlikely or incompatible with actual series of events (e.g., *Rüyamda, denize gitmişiz* ‘In my dream, we went to the seaside - INDIRECT’).

202 processing of the assumption marker (-DIr) and the direct evidential (-DI). This study
203 measured whether children are able to discriminate that a speaker expresses a degree of
204 certainty with the assumption marker and direct evidence with the direct evidential marker.
205 Their data showed that Turkish children are equally able to evaluate that the direct evidential
206 expresses a form of direct evidence and that the assumption marker signals a degree of
207 certainty, suggesting that acquisition of evidential and epistemic connotations develop equally
208 similarly in young Turkish children. Based on these findings, Aksu-Koç (2016) states for
209 Turkish that, at least for children, a boundary remains between epistemic and evidential
210 distinctions in the uses of the reported/inferred evidential (-mİş) and the epistemic modal
211 form for assumption (-DIr).

212 Another recent study by Tosun and Vaid (2018), using offline sentence judgement
213 tasks, examined groups of Turkish and English native speakers' sensitivity to the certainty
214 that events actually occurred (and how they would know that) in sentences marked for
215 evidentiality (i.e., hearsay, inference, and assumption²) and epistemic modality (i.e.,
216 necessity, probability, and possibility). An outcome of this study is that Turkish speakers
217 judged sentences marked for assumption (-DIr) and hearsay (-(I)mİş) as expressing lower
218 certainty than sentences marked for inference, consistent with the idea that the ownership of
219 information (inference vs. hearsay) impacts the certainty and reliability of the information
220 conveyed; English speakers, however, showed the opposite pattern by judging hearsay-
221 marked sentences with high certainty. Tosun and Vaid (2018) make a strong claim that their
222 data disprove the account that evidentiality is a disjoint category from epistemic modality,
223 proposing that evidentiality and epistemic modality are "not independent linguistic properties
224 from each other, nor are they the same structures conveying the same meaning" (p. 153).

² Please note that Tosun and Vaid (2018) appear to treat -DIr as a marker of "*inference from reasoning*" that signals a form of non-first-hand evidence (Tosun and Vaid 2018, pp. 131). The inferential/assumptive status of -DIr is well-grounded in Turkish; however, more recent accounts define -DIr an interface phenomenon marking epistemic modality and evidentiality (see Aksu-Koç 2016 for a discussion).

225 Karaslaan et al. (2018) took a probabilistic approach and built an epistemic Bayesian
226 model for Turkish speakers' trust of different kinds of information sources. The authors used
227 dialogues containing two characters discussing a particular topic. Participants were asked to
228 follow these dialogues and provide a rating whether they agree with the conclusions of one of
229 the characters regarding the topic. The participants showed a trend that Turkish speakers
230 found statements marked with direct evidentials more convincing than those with indirect
231 evidentials and evidentiality-neutral sentences, suggesting that marking for direct evidence
232 increases the source reliability.

233 The current study addresses evidentiality processing in Turkish and how it is
234 potentially influenced by different epistemic conditions. This study reports on four
235 experiments where the epistemic certainty of the speaker is neutral (Experiment 1),
236 manipulated with epistemic adverbs only for direct witnessing relevant to first-hand
237 information contexts (Experiment 2), and manipulated with epistemic adverbs under both
238 first-hand and non-first-hand information source contexts (Experiment 3). A fourth
239 experiment, using a short story completion task, was conducted to control for whether first-
240 hand witnessing is unnatural within statements with low epistemic certainty (Experiment 4).

241 An aim of this study is to understand how and to what extent evidential forms are
242 unacceptable within incompatible information source contexts. The findings of Arslan et al.
243 (2017) from a speed sentence verification experiment showed that indirect evidentiality in
244 first-person first-hand information source contexts is not favoured by native Turkish speakers
245 and judged as inappropriate very quickly during sentence listening. In Experiment 1, timed
246 sentence acceptability judgements were obtained to examine whether Turkish readers
247 perceive information source and evidentiality mismatches as acceptable during reading
248 comprehension. Under the assumption that indirect evidentiality is rather less natural or
249 incompatible within the speaker's first-hand information context, lower acceptability scores
250 are then expected for this condition.

251 The second aim of this paper is to test the claim that the presence of an epistemically
252 uncertain load hinders evidential processing. In other words, we examined whether direct and
253 indirect sources of knowledge are still judged to be equally acceptable when complemented
254 with epistemically modal predicates that express low or high certainty of the speaker. This is
255 based on the ESH (Clifton and Frazier 2016, 2018), which holds that skilled readers should be
256 sensitive to epistemic uncertainty in statements. It is already known from children’s language
257 acquisition research that epistemic certainty and reliability conditions interact with
258 evidentiality processing and acquisition (Matsui, Yamamoto, and McCagg 2006, Papafragou
259 et al. 2007, Fitneva 2008, Aksu-Koç 2016). However, if the tenets of the ESH are true, we
260 may observe that Turkish adults’ sentence interpretation is inherently biased to the direct
261 evidential since this form was shown to be epistemically more reliable (see, e.g., Karaslaan et
262 al. 2018), and lower certainty conditions should prove less acceptable than their high certainty
263 counterparts. These issues are addressed for first-hand information contexts in Experiment 2
264 and for both first-hand and non-first-hand contexts in Experiment 3.

265

266 **2. Experiment 1**

267 ***2.1. Participants***

268 A total of 41 native Turkish speakers (24 females) with a mean age of 25.22 (SD = 3.39,
269 range = 18–35) years participated in this experiment. The participants were recruited via the
270 web using the Ibex Farm platform (Drummond 2013) and were asked to give electronic
271 informed consent confirming that they were native Turkish speakers and had not been living
272 abroad for a significant duration at the time of testing. A language background questionnaire
273 revealed that all of the participants were residing in different regions in Turkey and were all
274 university students completing their bachelor’s or master’s degrees at the time of testing.
275 Individuals who reported to have lived abroad or were non-native Turkish speakers were
276 excluded from the analyses. One participant’s data were lost due to a technical error and

277 hence the data from the remaining 40 individuals were reported. Participation was voluntary
278 and participants were not monetarily remunerated. All stages of this experiment were in line
279 with the ethical requirements for human subjects (the Declaration of Helsinki).

280 *2.2. Materials and procedures*

281 A sentence stimulus set containing 24 sentences was created in four conditions (see the
282 Supplementary Materials for the full list of the sentence stimuli). Two conditions contained
283 pragmatically plausible and acceptable sentences where the given information source context
284 matches the verb evidentiality used, such as in (8a) and (8b). The other two conditions
285 contained a verb evidentiality that mismatched the information source context, such as (8c)
286 and (8d). The information source contexts were set by using short introductory clauses at the
287 beginning of each sentence. For witnessing contexts, the clause read *Ben gözümle gördüm* ‘I
288 saw with my eye’, indicating that the author of the sentence visually eye-witnessed the event,
289 and for reportative information contexts, the first clause was *Ben Merve'den duydum* ‘I heard
290 from Merve’, signalling that the author of the sentence has been told about the event from
291 another person.

292

293 (8) a. Witness–Direct (Match)

294 Ben göz-üm-le gör-dü-m Hilmi balıĝ-1 yakala-**dı** piknik-ten önce.

295 I eye-POSS-INSTR see-DIREVID-1SG Hilmi fish-ACC catch-DIREVID-Ø3SG picnic-ABL before.

296 ‘I saw with my own eye that Hilmi caught the fish before the picnic.’

297

298 b. Report–Indirect (Match)

299 Ben Merve'-den duy-du-m Hilmi balıĝ-1 yakala-**mıř** piknik-ten önce.

300 I Merve-ABL see-DIREVID-1SG Hilmi fish-ACC catch-INDIREVID-Ø3SG picnic-ABL before.

301 ‘I heard from Merve that Hilmi caught the fish before the picnic.’

302

303

304

305

306 c. Witness–Indirect (Mismatch)

307 Ben göz-üm-le gör-dü-m Hilmi balıĝ-ı yakala-mıř piknik-ten önce.

308 I eye-POSS-INSTR see-DIREVID-1SG Hilmi fish-ACC catch-INDIREVID-Ø3SG picnic-ABL before.

309 ‘I saw with my own eye that Hilmi caught the fish before the picnic.’ (the author suggests

310 that s/he witnessed an indirectly known event)

311

312 d. Report–Direct (Mismatch)

313 Ben Merve'den duydum Hilmi balıĝı yakala-dı piknikten önce.

314 I Merve.ABL see-DIREVID.1SG Hilmi fish-ACC catch-DIREVID.Ø3SG picnic.ABL before.

315 ‘I heard from Merve that Hilmi caught the fish before the picnic.’ (the author suggests that

316 s/he heard his/her own directly known event from Merve – a third person reporter)

317

318 Prior to the experimental sentences, an evidentiality-neutral clause (e.g., *Kovada büyük*

319 *bir balık var.* ‘There is a big fish in the bucket.’) was presented in order to neutralize any

320 expectations for either of the evidential forms at the beginning of the sentence since when

321 participants read the ‘information source’ clause, they may begin expecting an evidential

322 form. Thus, these evidentiality-neutral clauses help minimalize and delay any potential

323 predictions. In addition, 30 filler sentences were used in each list to avoid repetition effects

324 and prevent the participants from developing strategies. The filler sentences contained 10

325 semantically and 10 grammatically incongruent sentences and 10 congruent sentences. The

326 sentence stimuli were presented in four lists, each of which contained an equal number of

327 sentences from each condition and the filler sentences; thus, a participant read 54 sentences in

328 total. The critical sentences were presented in a moving-window paradigm, where each word

329 was shown for 500 ms in the centre of the screen. Once the presented word disappeared, the

330 next word appeared. The participants needed to hold the words in their memory and construct

331 the sentence meaning. Then, when the sentence presentation ended, an acceptability
332 judgement task requiring participants to provide a post-interpretative acceptability judgement
333 appeared. The participants were instructed to read the sentences word-by-word, evaluate the
334 acceptability of the sentences in terms of their meaning and integrity, and respond to the end-
335 of-sentence acceptability judgement question by pressing (f) for unacceptable and (j) for
336 acceptable. There were no time-outs. The next sentence began with a fixation cross after the
337 participants provided their response. Four practice items were given before the actual
338 experiment started in order to ensure that the participants understood the task. The
339 acceptability and reading time data were analysed using (generalized) linear mixed-effects
340 models and judgement accuracies with mixed-effects logistic regressions (Baayen, Davidson,
341 and Bates 2008). Following an a-priori screening, response times shorter than 200 ms and
342 longer than 3600 ms were removed, and the data were log-transformed before statistical
343 analyses.

344

345 ***2.3.Results and discussion***

346 Table 1 demonstrates the mean judgement acceptability rates and response times (RTs) for the
347 end-of-sentence acceptability task. Table 2 exhibits the statistical outputs from the linear
348 mixed-effects regression models computed using these data. The native Turkish readers'
349 acceptability judgement scores showed that they were sensitive to the mismatches between
350 the information source given and the evidential form appended at the critical verb. Significant
351 fixed effects of mismatches (see Table 2) suggest that the acceptability judgement scores were
352 lower in the mismatch conditions than when the sentence stimuli had an appropriate
353 information source context, irrespective of which evidential verb form was used.

Table 1. End-of-sentence acceptability judgment rates in proportions and response times in milliseconds (SD = standard deviation) across all the three experiments.

<i>Experiment 1</i>				
	Match		Mismatch	
	Direct	Indirect	Direct	Indirect
Acceptability	0.91 (0.28)	0.89 (0.30)	0.76 (0.42)	0.72 (0.45)
RTs	1201.70 (664.45)	1099.84 (619.29)	1115.85 (626.68)	1279.91 (722.21)
<i>Experiment 2</i>				
	High Certainty		Low Certainty	
	Direct	Indirect	Direct	Indirect
Acceptability	0.86 (0.34)	0.60 (0.49)	0.78 (0.41)	0.66 (0.47)
RTs	1257.28 (897.14)	1205.15 (894.21)	1194.70 (893.35)	1254.21 (921.52)
<i>Experiment 3</i>				
	High Certainty		Low Certainty	
	First Person	Third Person	First Person	Third Person
Acceptability	0.84 (0.37)	0.76 (0.43)	0.47 (0.50)	0.71 (0.45)
RTs	1277.81 (607.29)	1498.63 (953.30)	1783.63 (865.25)	1376.04 (725.18)

1 The statistical outputs from the linear regression model on the RT data, however, show
 2 significant interaction effects between the evidentiality and mismatch conditions. A post hoc
 3 comparison, using Tukey tests, showed that the interaction between mismatch and
 4 evidentiality marking seems to be modulated by the presence of evidentiality condition
 5 differences in the responses to the mismatching sentence stimuli ($\beta = 0.15$, $SE = 0.058$, $z =$
 6 2.65 , $p = 0.007$). That is, the Turkish readers took longer to respond when witnessed
 7 information source contexts are violated with an indirect evidential form than when a direct
 8 evidential violates reported information source contexts. No differences were found in the
 9 Turkish readers' response times to direct and indirect evidential verb form matching their
 10 corresponding contextual information ($\beta = -0.05$, $SE = 0.06$, $z = -0.86$, $p = 0.38$).

11
 12 **Table 2.** Statistical outputs from mixed-effects linear regression models computed with
 13 acceptability scores and response times data from Experiment 1. (SE = Standard error, p -
 14 values in the linear models were calculated with the Satterthwaite's method).

	<i>b</i>	<i>SE</i>	<i>z</i>	<i>p</i>
<i>Acceptability</i>				
Intercept	2.50	0.37	6.61	<0.001***
Evidentiality	-0.18	0.47	-0.37	0.70
Mismatch	-1.22	0.42	-2.88	0.003**
Evidentiality × Mismatch	-0.08	0.57	-0.14	0.88
<i>Response Times</i>				
Intercept	6.91	0.07	95.84	<0.001***
Evidentiality	-0.04	0.06	-0.69	0.48
Mismatch	-0.09	0.06	-1.52	0.12
Evidentiality × Mismatch	0.19	0.08	2.21	0.02 *

15 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

16

17 A purpose of Experiment 1 was to test the extent to which native Turkish speakers are
18 sensitive to verb evidentiality mismatches to given information source contexts. The findings
19 from Experiment 1 demonstrated that Turkish readers judged those mismatches as
20 unacceptable 72% of the time when an indirect evidential is used in a first-hand witnessing
21 context and 76% of the time when a direct evidential is used in report contexts. Further,
22 mismatches via an indirect evidential led to longer disruptions, as measured by longer end-of-
23 sentence judgement response times. The data reported here are in line with the findings of
24 Arslan et al. (2017) who observed that monolingual native Turkish speakers show immediate
25 sensitivity to mismatches via an indirect evidential in first-hand information contexts,
26 proposing that an indirect evidential form is rather incompatible in first-hand information
27 source contexts referring to one's own witnessed information. The empirical data provided
28 are therefore fully compatible with the idea that stating one's own witnessed information as
29 though it was reported by someone else is *counterintuitive* (Aikhenvald 2014, Curnow 2002).

30

31 **3. Experiment 2**

32 ***3.1. Participants***

33 Fifty-eight native Turkish speakers (33 females) with a mean age of 26.35 years (SD = 7.31,
34 range = 18–59) were recruited, following a similar procedure as in Experiment 1, using the
35 Ibex Farm platform. These participants did not take part in any other experiment reported in
36 this paper. They were all born and raised in Turkey, and they reported not having lived abroad
37 for a significant duration. Two individuals who reported to have acquired Turkish as a second
38 language were excluded; hence, the data from 56 participants were reported.

39

40

41

42

43 **3.2. Materials and procedures**

44 Twenty-four sentence stimuli were created with four conditions where the degree of certainty
45 and evidential form used were manipulated. In this experiment, all sentences contained a
46 contextual clause indicating visually witnessing the relevant first-hand evidence. Two
47 conditions (9a and 9c) included sentence material that started with a clause expressing the
48 high certainty of the speaker (i.e., *Ben gördüğüme eminim* ‘I am sure I saw that’). Two other
49 conditions (9b and 9d), however, contained a clause that conveyed lower certainty of the
50 speaker (*Ben gördüğümü sanıyorum* ‘I suppose I have seen that’). That is, in conditions 9a
51 and 9c, the speaker is highly certain to have witnessed the event expressed in the rest of the
52 sentence, while in conditions 9b and 9d, the speaker only supposes to have witnessed the
53 event, which implies relatively less reliable information. In half of the sentences, the
54 evidential form used at the critical verb was a direct evidential, the use of which is compatible
55 with the first-hand witnessing contexts (9a and 9b), whereas in the other half of the sentences,
56 an indirect evidential was used, which is not compatible with a first-hand information source
57 context. The experimental procedures regarding participant recruitment and stimulus
58 presentation procedures were the same as in Experiment 1. recruitment and stimulus
59 presentation procedures were the same as Experiment 1.

60

61

62 (9) a. High certainty – direct

63 Ben gör-düğ-üm-e emin-im Hilmi balıĝ-1 yakala-**dı** piknik-ten önce.

64 I see-PASTPART-1SG-DAT sure-1SG Hilmi fish-ACC catch-DIREVID-3SG picnic-ABL before.

65 ‘I am certain to have seen that Hilmi caught the fish before the picnic.’

66

67

68

69 b. Low certainty – direct

70 Ben gör-düğ-üm-ü san-ıyor-um Hilmi balığ-ı yakala-**dı** piknik-ten önce.

71 I see-PASTPART-1SG-ACC suppose-PRES-1SG Hilmi fish-ACC catch-DIREVID3SG picnic.ABL before.

72 ‘I suppose I have seen that Hilmi caught the fish before the picnic.’

73

74 c. High certainty – indirect

75 Ben gör-düğ-üm-e emin-im Hilmi balığ-ı yakala-**mış** piknik-ten önce.

76 I see-PASTPART-1SG.DAT sure-1SG Hilmi fish-ACC catch-INDEVID-3SG picnic.ABL before.

77 ‘I suppose I have seen that Hilmi caught the fish before the picnic.’

78

79 d. Low certainty – indirect

80 Ben gör-düğ-üm-ü san-ıyor-um Hilmi balığ-ı yakala-**mış** piknik-ten önce.

81 I see-PASTPART-1SG-ACC suppose-PRES-1SG Hilmi fish-ACC catch-INDIREVID-3SG picnic.ABL before.

82 ‘I suppose I have seen that Hilmi caught the fish before the picnic.’

83

84 ***3.3.Results and discussion***

85 Table 1 presents the end-of-sentence acceptability judgement rates and response times. A

86 mixed-effects regression model of the acceptability scores showed significant fixed effects of

87 evidentiality ($\beta = -1.55$, $SE = 0.28$, $z = -5.09$, $p < 0.001$) but nonsignificant fixed effects of

88 epistemic uncertainty ($\beta = -0.45$, $SE = 0.32$, $z = -1.38$, $p = 0.16$) and a nonsignificant

89 interaction term between the two factors ($\beta = 0.66$, $SE = 0.41$, $z = 1.60$, $p = 0.11$). These

90 results evidenced that Turkish readers’ acceptability preferences were significantly greater for

91 direct evidentials than indirect evidentials in both high and low certainty conditions. This

92 pattern for greater acceptability scores for direct evidentials in visual witnessing contexts was

93 independent of epistemic certainty manipulations since the responses for direct evidentials did

94 not differ in both the low and high epistemic certainty conditions ($\beta = -0.01$, $SE = 0.03$, $z = -$

95 0.32, $p = 0.74$). Regarding the end-of-sentence response times, no critical differences were
96 found since all the comparisons were nonsignificant (all $ps > 0.23$).

97 The findings of Experiment 2 further confirmed that uses of indirect evidentiality are
98 less compatible than direct evidentiality in first-hand witnessed contexts and the presence of
99 high and low epistemic uncertainty, indicating that the speaker's attitude towards his/her first-
100 hand knowledge did not influence this pattern. In other words, disregarding whether the
101 speaker is certain to have witnessed or only thinks they have witnessed the event expressed in
102 the proposition, indirect evidentiality in first-hand witnessing contexts elicits lower
103 acceptability scores. Turkish readers' sensitivity to the incompatibility of indirect
104 evidentiality within first-hand witnessing contexts overrides the uncertainty of the speaker's
105 own witnessing, casting doubt on the idea that indirect evidentiality in Turkish inherently
106 implies a lower degree of reliability. However, the main focus of this experiment was on
107 readers' sensitivity to direct/indirect evidentiality in first-hand witnessing contexts. Without
108 non-first-hand contexts that require uses of indirect evidentiality, potential influences of
109 epistemic uncertainty of the speaker may not immediately be visible. Therefore, a third
110 experiment was designed with both first-hand and non-first-hand source contexts and no
111 evidentiality mismatches.

112

113 **4. Experiment 3**

114 ***4.1. Participants***

115 Thirty-five native Turkish speakers participated (20 females, mean age = 30.63, SD = 8.47,
116 range = 22–58). The participants were recruited through the same web-based platform, Ibex
117 Farm, and none of them took part in Experiment 1 or 2. All the participants reported to have
118 been born and raised in Turkey and were native Turkish speakers, and none had lived abroad
119 for a significant duration.

120

121

122 ***4.2. Materials and procedure***

123 Twenty-four pragmatically acceptable sentence stimuli were created with four conditions
124 where the owner of the information (first versus third person) and epistemic certainty
125 conditions (high vs. low) were manipulated. In one condition, statements were based on the
126 first-person contexts, signalling that the speaker has direct access to the information
127 mentioned in this statement, such as in (10a). However, in a second condition, the information
128 belonged to a third-person, conveying that the speaker had been told about this event, such as
129 in (10b). Across the experimental stimuli, the epistemic certainty of the speaker was
130 manipulated as high and low by using verb semantics (i.e., *eminim* ‘I am sure’ vs. *saniyorum*
131 ‘I think/suppose’). The experimental procedures regarding participant recruitment and the
132 stimulus presentation procedures were the same as in Experiment 1. The same filler items
133 were used.

134 (10) a. High / Low epistemic certainty in first person context

135 Ben o-nun balıĝ-1 yakala-dıĝ-1n-1 *gör-düĝ-üm-e* *emin-im* / *gör-düĝ-üm-ü* *san-ıyor-um.*

136 I him-POSS fish-ACC catch-PASTPART-ACC see-PASTPART-1SG-DAT sure-1SG / see-PASTPART-1SG-ACC suppose-PRES-1SG

137

138 Hilmi balıĝ-1 yakala-dı piknik-ten önce.

139 Hilmi fish.ACC catch-DIREVID-3SG picnic-ABL before.

140 ‘I am sure / I suppose that I have seen him catching the fish. Hilmi caught the fish before the picnic.’

141

142 b. High / Low epistemic certainty third person reported context

143 Merve o-nun balıĝ-1 yakala-dıĝ-1n-1 *gör-düĝ-ün-e* *emin* / *gör-düĝ-ün-ü* *san-ıyor.*

144 Merve him-POSS fish-ACC catch-PASTPART-ACC see-PASTPART-3SG-DAT sure-1SG / see-PASTPART-1SG-ACC suppose-PRES-3SG

145

146 Hilmi balıĝ-1 yakala-mış piknik-ten önce.

147 Hilmi fish-ACC catch-INDIREVID-3SG picnic-ABL before.

148 ‘Merve is sure / Merve supposes that she has seen him catching the fish. Hilmi caught the fish before the picnic.’

149

4.3. Results and discussion

150 Table 1 presents the mean end-of-sentence responses and response times, and Table 3
151 presents the outputs from the linear mixed-effects regression models computed with
152 acceptability and the RT data. The model outputs for the acceptability rating data show
153 significant fixed effects of epistemic uncertainty and an interaction between epistemic
154 uncertainty and the information source. This indicates that the Turkish readers found
155 epistemically uncertain statements to be unacceptable to a greater extent than they did for
156 epistemically certain statements. The interaction between epistemic uncertainty and the
157 information source was because the high certainty in the first-person context condition (84%)
158 was judged as largely more acceptable than the low certainty in the first-person context
159 condition (i.e., 47%; $\beta = -0.35$, $SE = 0.09$, $z = -3.52$, $p < 0.001$). Furthermore, the low
160 certainty in first-person context condition proved to be significant different from the low
161 certainty in third-person context condition (71%; $\beta = 0.21$, $SE = 0.11$, $z = 2.01$, $p = 0.04$). That
162 is, epistemic uncertainty about an event being true is more compatible with non-first-person
163 (i.e., non-first-hand) information source contexts that require the use of indirect evidentiality
164 when compared to first-person information source contexts requiring direct evidentiality.
165 Regarding the response time data, the model outputs mirrored the acceptability rate data since
166 there were significant fixed effects of epistemic certainty and an interaction of this factor with
167 the information source. The Turkish readers responded slower to the end-of-sentence
168 acceptability judgement questions in sentences denoting epistemic uncertainty compared to
169 those that denote epistemic certainty. Within the sentences expressing first-hand witnessed
170 information, the lower certainty condition was responded to with longer response times
171 compared to the higher certainty condition ($\beta = 0.29$, $SE = 0.09$, $t = 3.22$, $p = 0.001$). This
172 comparison, however, was insignificant for sentences with non-first-hand information
173 contexts ($\beta = -0.01$, $SE = 0.11$, $t = -0.15$, $p = 0.87$). Similar to the acceptability data, the
174 Turkish readers' end-of-sentence response times to the sentences with first-person

175 information complemented with modal predicates expressing epistemic uncertainty elicited
 176 longer response times (1783 ms) than sentences with non-first-person information ($\beta = -0.27$,
 177 $SE = 0.11$, $t = -2.45$, $p = 0.01$). This difference between first-hand and non-first-hand
 178 information was not significant for epistemically certain sentences ($\beta = 0.03$, $p = 0.71$).

179

180 **Table 3.** Statistical outputs from mixed-effects linear regression models in Experiment 3. (SE
 181 = Standard error, p -values in the linear models were calculated with the Satterthwaite's
 182 method).

	<i>b</i>	<i>SE</i>	<i>z</i>	<i>p</i>
<u>Acceptability rates</u>				
Intercept	0.83	0.06	12.38	<0.001***
Information Source	-0.07	0.09	-0.75	0.45
Epistemic Certainty	-0.35	0.10	-3.48	<0.001***
Information Source × Epistemic Certainty	0.29	0.14	2.08	0.03*
<u>Response Times</u>				
	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>
Intercept	7.08	0.08	82.85	<0.001***
Information Source	0.03	0.10	0.32	0.74
Epistemic Certainty	0.28	0.10	2.70	0.007**
Information Source × Epistemic Certainty	-0.31	0.14	-2.13	0.03 *

183 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

184

185 The findings from Experiment 3 suggest that Turkish readers find sentence contexts
 186 expressing one's own witnessed information with low certainty rather less acceptable (e.g.,
 187 *Ben onun balığı yakaladığını gördüğümü sanıyorum, Hilmi balığı yakaladı* 'I suppose I've
 188 seen that Hilmi caught.DIRECT EVIDENTIAL the fish'). A possible reason for low acceptability
 189 scores on these sentences may be a result of semantic and/or pragmatic effects. Specifically,
 190 the speaker thinks that s/he might have witnessed an event marked with direct evidentiality,

191 resulting in an unsettling pragmatic effect where the proposition denotes epistemic
192 uncertainty of one's own witnessing, but the use of a direct evidential suggests otherwise.
193 Therefore, uses of a non-first-hand source marked with indirect evidentiality in such
194 circumstances are more acceptable in Turkish. The results from this study indicate that when
195 a first-person speaker talks about his/her direct evidence within a statement that expresses low
196 epistemic certainty, thereby signalling that the speaker is unsure of his/her own witnessing,
197 uses of direct evidentiality are rather unacceptable. However, these lower acceptability scores
198 observed may be simply due to the readers' expectancy of an assumption marker at the
199 critical verb (i.e., -DIr) instead of a direct evidential marker. Hence, a fourth experiment with
200 a forced-choice ministory completion design was conducted to explore which of the three
201 evidential and epistemic markers (direct, indirect evidential and assumption) are naturally
202 preferred in first-hand witnessing contexts with different uncertainty conditions.

203

204 **5. Experiment 4**

205 **5.1. Participants**

206 A total of 31 native Turkish speakers (19 females, mean age = 23.90, SD = 1.99, range = 17–
207 28) voluntarily participated in Experiment 4. The participants were asked to complete a small
208 questionnaire about their language background. They reported to have been living in Turkey
209 at the time of testing and reported no extended stays abroad. None of these participants
210 participated in the previous experiments described above.

211

212

213 **5.2. Materials and procedure**

214 Twelve pieces of discourse material were chosen to create two-sentence ministories across
215 two conditions (i.e., a total of 24 items). In each sentence pair, an evidentiality-neutral
216 contextual clause was used (e.g., *Dolaptaki yemek ortada yok*. 'The food is not in the fridge').

217 After this contextual clause, a critical sentence was manipulated in either epistemically low
218 certainty (11a) or high certainty conditions (11b).

219

220 (11) Firsthand direct witnessing with high/low certainty conditions

221 a. Ben o-nun yemeğ-i ye-diğ-in-i gör-düğ-üm-den emin-im.

222 I him-POSS food-ACC eat-PASTPART-ACC see-PASTPART-1SG-ABL sure-1SG

223 'I am sure I have seen him eating the food.'

224

225 b. Ben o-nun yemeğ-i ye-diğ-in-i gör-düğ-üm-ü san-ıy-or-um.

226 I him-POSS food-ACC eat-PASTPART-ACC see-PASTPART-1SG-ACC suppose-PRES-1SG

227 'I suppose I have seen him eating the food.'

228

229 These ministories were programmed via a web browser using the Google Forms platform
230 and presented to each participant individually through the internet with the distant supervision
231 of Turkish-speaking research assistants. Each ministory was presented on a single window
232 with three sentence lines. The context and critical sentences were shown on the screen in
233 separate lines; and the third line was truncated (i.e., _____), signalling that the participants
234 need to complete the story with a sentence. Underneath the presented ministories, three
235 answer options were given to the participants to choose from and their task was to respond by
236 clicking on the most appropriate answer option according to their intuition. The answer
237 options included a simple declarative Subject-Object-Verb sentence where the verb was
238 marked with either a direct evidential (12a), an indirect evidential (12b), or an assumption
239 marker (12c). The experiment allowed the participants to respond by clicking on only one
240 answer option.

241

242 (12) Response options

243 a. Mualla yemeğ-i ye-di.

244 Mualla food-ACC eat-DIRECT EVID

245 ‘Mualla ate the food’ [witnessed]

246

247 b. Mualla yemeğ-i ye-miş.

248 Mualla food-ACC eat-INDIRECT EVID

249 ‘Mualla ate the food’ [inferred / reported]

250

251 c. Mualla yemeğ-i ye-miş-tir.

252 Mualla food-ACC eat-INDIRECT EVID-ASSUMPTION

253 ‘Mualla must have eaten the food.’

254

255 The participants’ numbers of responses were quantified as to whether they completed the
256 ministories with direct evidentials (12a), indirect evidentials (12b) or assumption markers
257 (12c). The raw numbers of responses were initially summarized in a 3 × 2 contingency table
258 with epistemic certainty manipulations (low vs. high certainty) and different answer options
259 (direct vs. indirect vs. assumption markers). Then, the data were subjected to a chi-squared
260 test of independence. Pairwise condition comparisons were computed using the Wilcoxon
261 signed-rank test with per participant occurrence counts of each answer option across the high
262 and low certainty conditions. The Bonferroni correction was applied to the *p*-values.

263

264 ***5.3.Results and discussion***

265 Table 4 demonstrates the counts and percent responses to the ministory completion task. The
266 data pattern clearly indicates that in the high certainty condition, the Turkish respondents
267 favoured using a direct evidential (81.4%) among all possible answer options. In the low
268 certainty condition, by contrast, the most frequently favoured answer option was the

269 assumption marker (67.7%). A chi-squared test of independence showed a significant
 270 relationship between epistemic certainty (high vs. low) and different response options ($X^2(2)$
 271 = 124.86, $p < 0.001$). See Table 4 for the contingency table data. Pairwise comparisons show
 272 that the direct evidential form was chosen as an answer option more frequently in the high
 273 certainty than in the low certainty condition (81.4% vs. 12.9%, $W = 406$, $N = 31$, $p < 0.001$)
 274 and that the assumption marker was favoured more frequently as an answer option in the low
 275 certainty than in the high certainty condition (7.3% vs. 67.7%; $W = 4.5$, $N = 31$, $p < 0.001$).
 276 However, the frequencies of the participants' choices of an indirect evidential form as an
 277 answer option did not show any differences under high and low certainty conditions (11.3%
 278 vs. 19.3%; $W = 56$; $N = 31$, $p = 0.18$).

279

280 **Table 4.** Percent responses (frequency of counts in parentheses) to the mini-story completion
 281 task. Max possible response per condition is 124. In squared brackets X^2 statistics are
 282 presented for each cell.

283

Answer option	High Certainty	Low Certainty
<i>Direct evidential</i>	81.4% (101) [30.88]	12.9% (16) [30.88]
<i>Indirect evidential</i>	11.3% (14) [1.32]	19.3% (24) [1.32]
<i>Assumption marker</i>	7.3% (9) [30.24]	67.7% (84) [30.24]
<i>Total</i>	100% (124)	100% (124)

284

285 An aim of Experiment 4 was to control which evidential form native Turkish speakers
 286 prefer in first-hand witnessing contexts expressing low versus high certainty of the speaker.
 287 The results from the current experiment showed that for statements that express first-hand
 288 witnessing and low certainty at the same time, native Turkish speakers prefer neither direct
 289 nor indirect evidential, but they show a strong preference for assumption markers. Therefore,

290 it can be concluded that uses of direct evidentials are inconsistent or least favoured in contexts
291 where the speaker expresses uncertainty over his/her own witnessing.

292

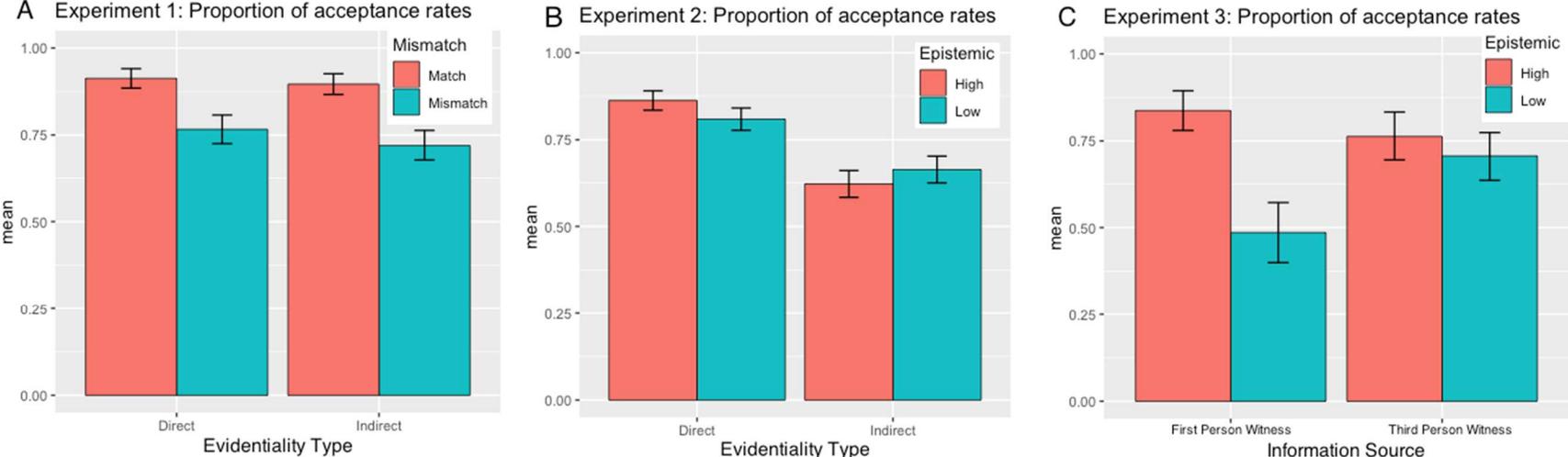
293 **6. Summary and General Discussion**

294 This study investigated to what extent evidentiality processing in Turkish is influenced under
295 different epistemic certainty conditions related to the speaker's own witnessing and
296 information ownership in order to address two overarching aims. The first aim was to
297 understand how sensitive Turkish readers are to mismatches between evidential marking and
298 information source contexts. In other words, if one uses an indirect evidential in Turkish for
299 an event that s/he witnessed, is that acceptable? The second aim was to identify whether the
300 degree of epistemic uncertainty of the speakers' own information impacts evidentiality
301 processing. That is, when the owner of the information is not sure that s/he knows that
302 information, what happens?

303 Figure 1 summarizes the end-of-sentence acceptability judgement responses across
304 Experiments 1–3. Recapitulating the key results from this study, Experiment 1 showed that
305 evidentials that mismatch an appropriate information source are less acceptable overall and
306 that uses of indirect evidentials in first-hand witnessing contexts elicit greater post-
307 interpretive response disruptions during sentence reading than uses of direct evidentials in
308 non-first-hand information source contexts. Experiment 2 showed that indirect evidentiality is
309 rather incompatible in first-hand witnessed contexts, further informing that the speaker's
310 certainty over his/her witnessing does not influence this incompatibility to a significant
311 extent. That is, Turkish readers find direct evidentials to be more compatible in first-person
312 direct witnessing situations, disregarding whether the speaker is sure s/he witnessed this
313 situation or only assumes to have witnessed it. The findings from Experiment 3 suggested that
314 first-person witnessing marked with direct evidentiality is rather unacceptable when expressed
315 under low epistemic certainty conditions (i.e., the speaker is unsure of his/her own

316 witnessing), possibly due to a semantic-pragmatic effect since one's own witnessed
317 information with low certainty is rather unfavoured (as low as 47%, see Figure 1C).
318 Experiment 4 confirmed that the Turkish readers strongly favour the direct evidential when
319 the sentential context expresses high certainty of the first-person witness; but for low certainty
320 of first-person witness conditions, Turkish speakers strongly prefer the evidential/epistemic
321 assumption marker complex (-mİş + -Dİr).

Figure 1. A summary of acceptability scores across Experiments 1 – 3. Mismatch in 1A refers to match/mismatch condition manipulations between information source contexts and the evidential form, and Epistemic in 1B and 1C refers to epistemic certainty manipulations.



1 Regarding the first aim, this study clearly concludes that Turkish speakers are
2 sensitive to information source–evidential form mismatches and that there is an asymmetry in
3 their post-interpretive acceptability judgements. That is, indirect evidential form mismatching
4 to a first-hand information source context evoked greater disruptions as measured by longer
5 response times than direct evidential mismatching to non-first-hand information. Specifically,
6 the direct evidential in a non-first-hand context may be interpreted as ‘expected news’ or
7 consolidated information, and hence it may have been processed as acceptable by the Turkish
8 readers. Furthermore, an indirect evidential in a first-hand context is rather unsettling,
9 although under some infrequent circumstances, one can use such a contextual mismatch to
10 describe a dream. This is fully compatible with the findings of Arslan et al. (2017) that
11 indicated that a group of native Turkish speakers showed immediate sensitivity to mismatches
12 using an indirect evidential in first-hand information contexts. Please note that Arslan et al.
13 (2017) report shorter response times for this condition because they used a go/no-go design
14 where their participants were instructed to provide a response as quickly as possible to
15 information–evidentiality mismatches during sentence listening (or no response if the
16 sentence has no mismatch); hence shorter responses in this type of experiment indicate
17 immediate and robust sensitivity. In the current study, however, a word-by-word presentation
18 was used in which the participants need to hold words in memory and construct the sentence
19 meaning at the end before they can judge the acceptability of the sentences. This design
20 involves post-interpretive processes (i.e., offline consideration of the participants’ intuition
21 over the presented sentence) where longer response times indicate a greater disruption in
22 applying these processes. Therefore, the findings from the current study point to the same
23 conclusion as the earlier data that indirect evidentiality is rather unacceptable in first-hand
24 information contexts since Turkish speakers notice this type of mismatch immediately and
25 quickly during listening (Arslan, et al., 2017), and they exhibit longer offline response times
26 to end-of-sentence acceptability judgements (the current study, Experiment 1). Uses of

27 indirect evidentiality in reference to one's own information are in fact unintuitive in a number
28 of other evidential languages (see Aikhenvald 2004 for an overview).

29 Regarding the second aim, where the central question was whether epistemic
30 uncertainty conditions influence evidentiality processing, the results from Experiments 2–4
31 indicate that the owner's degree of uncertainty over the information does impact evidentiality
32 processing. However, the influence of epistemic uncertainty on evidentiality is not simple and
33 straightforward, so there is a complex interface between the two notions where the owner of
34 the information also matters. Experiment 2 showed that first-person witnessing contexts
35 manipulated for either low and high epistemic certainty of the speaker do not
36 straightforwardly influence the preference for a direct evidential. Nonetheless, Experiment 3
37 showed that uses of direct evidentials when the speaker is unsure of his/her own witnessing
38 are not favoured by Turkish speakers. The outcomes from these two experiments seem to
39 conflict. A possible reason for this is that the contextual sentences were different in these two
40 experiments. In Experiment 2, rather short contextual clauses were used (i.e., *Ben gördüğümü*
41 *saniyorum* 'I suppose I saw') and the evidential form either matched (direct evidential) or
42 mismatched (indirect evidential) this contextual clause. In Experiment 3, the contextual
43 clauses were presented in two conditions, information expressed in the proposition owned by
44 a first-person (10a) and non-first-person perspective (10b), and the evidential verb used was
45 appropriate to the information source. This allowed both owner perspectives to be explored
46 during sentence reading. Comparing the findings from Experiments 2 and 3, it is imaginable
47 that contextual information affects Turkish readers' acceptability responses for sentences with
48 indirect evidentials during their post-interpretive judgements as to whether or not indirect
49 evidentiality codifies lower uncertainty. An anonymous reviewer stated that the lexical
50 aspectual values of verbs may be an issue here, which is a limitation of the current study since
51 the lexical aspects of the verbs used in this study were not controlled for, although almost all
52 verbs used were accomplishment or achievement verbs. For instance, accomplishment verbs

53 (e.g., to catch a fish) encode a culmination point and evident consequences based on which
54 one can infer that the event in the proposition happened without overtly observing the actual
55 event, in turn intensifying the speaker's certainty about an event being true. Thus, a future
56 study may examine the interaction between the lexical aspect and evidentiality processing
57 with regard to epistemic uncertainty. A common outcome from the experiments reported in
58 this study, however, seems to suggest that the epistemic uncertainty of the
59 speaker/information owner influences evidentiality processing. While a direct evidential is
60 appropriate under a scenario where a first-person information owner certainly witnessed the
61 event, an indirect evidential (or the assumption marker) is acceptable in reference to a non-
62 first-person's uncertainty regarding his/her information.

63 Findings from this study support Clifton and Frazier's (2016, 2018) epistemic state
64 hypothesis, which stated that Turkish readers were expected to judge the sentence stimuli
65 expressing epistemically uncertain connotations to be virtually unacceptable. This was shown
66 in Experiment 3, where epistemically uncertain sentences were rated as rather unacceptable
67 and elicited longer response times than epistemically certain sentences. Furthermore, in
68 Experiment 2, lower acceptability scores for sentences with indirect evidential forms
69 compared to those with direct evidential forms can be taken as converging support for ESH's
70 line of reasoning assuming that an indirect evidential often expresses a lower degree of
71 epistemic certainty.

72 According to a widespread view in Turkish linguistics, the assumption marker (-DIr) is
73 treated as an epistemic modal form signifying a continuum of certainty (Aksu-Koç and Alıcı
74 2000, Aksu-Koç 2016, Temürcü 2007, Tura 1986 among others). The finding from
75 Experiment 4 that the Turkish speakers favoured assumption markers (i.e., -mİş + -DIr) in
76 the low certainty condition particularly fits in with an interface framework for epistemic
77 modality and evidentiality (Aksu-Koç 2016). According to Aksu-Koç (2016, pp 149), "when
78 a statement with -mİş is further marked with -DIr, the evidential statement making a factual

79 assertion becomes epistemically modalized, and is interpreted as a speculation [...]”. The
80 epistemically modal status of an assumption marker (–Dir) can be accommodated when the
81 notion of subjectivity is applied (Lyons 1977, Nuyts 2001b), where the speaker has no quality
82 evidence for an epistemic evaluation of the event being true. Furthermore, direct evidentials
83 seem to involve certainty connotations of the speaker’s knowledge given the findings from
84 the current study, which consistently showed when a first-person speaker is certain of his
85 knowledge, a direct evidential is always preferred. This is also compatible with Karaslaan et
86 al. (2018) who suggested that direct evidentiality is related to increased source reliability. If
87 certainty is a scale that goes from certain to uncertain, based on the empirical data provided
88 above, it may be possible to position the evidential markers according to their epistemic
89 values on the certainty scale: direct evidentials (full evidence), indirect evidentials (partial
90 evidence), and assumption markers (nonevidence).

91 This analysis by no means concerns the grammaticalization debate on evidentiality and
92 epistemic modality. However, it should be recognized that in certain languages, evidential
93 markers expose epistemic meanings (e.g., Nuyts 2001b, Cornillie 2009, Faller 2002, Van der
94 Auwera and Plungian 1998, Dendale and Tasmowski 2001), and in fact, it is not uncommon
95 that evidential markers have epistemic values (Vilas 2020). See the volumes in Lee and Park
96 (2020) for further discussions. Based on the results from the current study, which are fully
97 reconcilable with Aksu-Koç’s (2016) interface model, the most ideal conclusion for the nature
98 of evidentials in Turkish is that evidentiality is influenced by the ‘certainty of the information
99 owner’. That is, there is an interaction between the person who owns the information (first-
100 person or non-first-person) and how certain the owner is about his/her information. When the
101 owner is the first-person, hence making the use of a first-hand evidentiality acceptable, low
102 certainty regarding the knowledge is rather unexpected or unsettling. However, when the
103 owner is non-first-person, uncertainty regarding the knowledge is relatively more compatible.

104

105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130

References

Aikhenvald, A. Y., 2003. Evidentiality in typological perspective. In: Aikhenvald, A.Y., Dixon, R. M. W (Eds.), *Studies in evidentiality*, John Benjamins, Amsterdam, pp.1-32.

Aikhenvald, A. Y. 2004. *Evidentiality*. Oxford University Press, Oxford.

Aikhenvald, A. Y. 2014. The grammar of knowledge: a cross-linguistic view of evidentials and the expression of information source. In: Aikhenvald, A.Y., Dixon, R. M. W (Eds.), *The Grammar of Knowledge: A Cross-Linguistic Typology*, Oxford University Press, Oxford, pp. 1-51.

Aksu-Koç, A. 1988. *The acquisition of aspect and modality: The case of past reference in Turkish*. Cambridge University Press, Cambridge.

Aksu-Koç, A. 2000. Some aspects of the acquisition of evidential in Turkish. In: Johanson, L., Utas, B. (Eds.), *Evidentials: Turkic, Iranian and neighbouring languages*. Walter de Gruyter, Berlin, pp. 15-28.

Aksu-Koç, A., 2016. The interface of evidentials and epistemics in Turkish. In: Güven, M., Akar, D., Öztürk, B., Keleşir, M. (Eds), *Exploring the Turkish Linguistic Landscape: Essays in honor of Eser Erguvanlı-Taylan*. John Benjamins, Amstredam, pp. 143–156.

Aksu-Koc, A., Alici. D. M., 2000. Understanding sources of beliefs and marking of uncertainty: The child’s theory of evidentiality. In: Clark, E.V. (Ed), *The Proceedings of the Thirtieth Child Language Research Forum*. Centre for the Study of Language and Information, Stanford, pp. 123–130.

Aksu-Koç, A., Slobin, D. I., 1986. A psychological account of the development and use of evidentials in Turkish. In: Chafe, W., Nichols, J. (Eds), *Evidentiality. The linguistic coding of epistemology*. Ablex Publishing Corporation, New Jersey, pp. 159-167.

- 131 Aksu-Koç, A., Ögel-Balaban, H., Alp, İ. E., 2009. Evidentials and source knowledge in
132 Turkish. In: Fitneva, S. A., Matsui, T. (Eds), *Evidentiality: A window into language*
133 *and cognitive development*, New directions for child and adolescent development.
134 Jossey-Bass, San Francisco, pp. 13-28.
- 135 Arslan, S, Bastiaanse R., & Felser, C., 2015. Looking at the evidence in visual world: eye-
136 movements reveal how bilingual and monolingual Turkish speakers process
137 grammatical evidentiality. *Frontiers in Psychology* 6.
- 138 Arslan, S, de Kok, D & Bastiaanse, R., 2017. Processing grammatical evidentiality and time
139 reference in Turkish heritage and monolingual speakers. *Bilingualism: Language and*
140 *Cognition* 20.457-72.
- 141 Arslan, S. 2020, Processing evidentiality in bilingualism and aphasia: an overview of some
142 recent studies on Turkish. In: Lee, J. & Park, C. (Eds), *Evidentials and Modals*. Brill,
143 pp. 447–459.
- 144 Baayen, R. H., Davidson, D. J., Bates, D., 2008. Mixed-effects modeling with crossed random
145 effects for subjects and items. *Journal of memory and language*, 59(4), 390-412.
- 146 Boye, K., 2010. Semantic maps and the identification of cross-linguistic generic categories:
147 Evidentiality and its relation to epistemic modality. *Linguistic Discovery*, 8(1), 4-22.
- 148 Chafe, W., Nichols, J., 1986. *Evidentiality: The linguistic coding of epistemology*. Ablex
149 Publishing, New Jersey.
- 150 Clifton, C., Frazier, L., 2016. Accommodation to an unlikely episodic state. *Journal of*
151 *memory and language*, 86, 20-34.
- 152 Clifton, C., Frazier, L., 2018. Evaluation of the epistemic state of the speaker/author. *The*
153 *Quarterly Journal of Experimental Psychology*, 71(6), 1482-1492.
- 154 Cornillie, B., 2009. Evidentiality and epistemic modality: On the close relationship between
155 two different categories. *Functions of language*, 16(1), 44-62.

156 Csató, Eva A. 2000. Turkish mis- and imis-items. Dimensions of a functional analysis. In: L.
157 Johanson & B. Utas (eds), *Evidentials: Turkic, Iranian and neighbouring languages*,
158 Mouton de Gruyter, Berlin, pp. 29-46.

159 Curnow, T. J., 2002. Types of interaction between evidentials and first-person subjects.
160 *Anthropological Linguistics*, 44(2), 178-196.

161 De Haan, F., 1999. Evidentiality and epistemic modality: Setting boundaries. *Southwest*
162 *Journal of Linguistics*, 18(1), 83-101.

163 De Haan, F., 2005. Encoding speaker perspective: Evidentials. In: Frajzyngier, Z., Hodges,
164 A., Rood, D. S. (Eds), *Linguistic Diversity and Language Theories*. John Benjamins,
165 Amsterdam, 379-397.

166 Dendale, P., Tasmowski, P., 2001. Introduction: Evidentiality and related notions. *Journal of*
167 *Pragmatics*, 33(3), 339-348.

168 Drummond, A., 2013. *ibex farm*. Online server: <http://spellout.net/ibexfarm>.

169 Erguvanlı-Taylan, E. 1997. The Relationship between Aspect, Tense and Modality in
170 Turkish: the Morpheme -DI. In: Zeyrek, D. & Ruhi, Ş. (Eds.), XI. Dilbilim Kurultayı
171 Bildirileri. Middle East Technical University Press, Ankara, 1-13.

172 Faller, M. T., 2002. *Semantics and pragmatics of evidentials in Cuzco Quechua*. PhD Thesis,
173 Stanford University.

174 Fitneva, S. A., 2001. Epistemic marking and reliability judgments: Evidence from Bulgarian.
175 *Journal of Pragmatics*, 33(3), 401-420.

176 Fitneva, S. A., 2008. The role of evidentiality in Bulgarian children's reliability judgments.
177 *Journal of Child Language*, 35(4), 845-868.

178 Givón, T., 1982. Evidentiality and epistemic space. *Studies in Language*, 6(1), 23-49.

179 Göksel, A., Kerslake, C., 2005. *Turkish A Comprehensive Grammar*. Routledge, London.

180 Halliday, M.A.K., 1970. Functional diversity in language as seen from a consideration of
181 modality and mood in English. *Foundations of Language*, 6(3), 322-361.

182 Johanson, L., 2000. Turkic indirectives. In: Johanson, L., Utas, B. (Eds.), *Evidentials: Turkic,*
183 *Iranian and neighbouring languages.* Walter de Gruyter, Berlin, pp. 61-88.

184 Johanson, L., Utas, B., 2000. *Evidentials: Turkic, Iranian and neighbouring languages.* Walter
185 de Gruyter.

186 Karaslaan, H., Hohenberger, A., Demir, H., Hall, S., Oaksford, M., 2018. Cross-cultural
187 differences in informal argumentation: norms, inductive biases and evidentiality.
188 *Journal of Cognition and Culture*, 18(3/4), 358-389.

189 Kerimoğlu, C., 2010. On the epistemic modality markers in turkey turkish: Uncertainty.
190 *Turkish Studies*, 5(4), 432-478.

191 Kornfilt, J., 2013. *Turkish.* Routledge, London.

192 Lazard, G., 2001. On the grammaticalization of evidentiality. *Journal of Pragmatics*, 33(3),
193 359-367.

194 Lee, C., Park, J. 2020. *Evidentials and Modals.* Brill.

195 Lucas, A., Lewis, J.C, Pala, F.C., Wong, K., Berridge, D., 2013. Social-cognitive processes
196 in preschoolers' selective trust: Three cultures compared. *Developmental psychology*,
197 49(3), 579–590.

198 Lyons, J. 1977. *Semantics.* Cambridge University Press, Cambridge.

199 Matsui, T., Yamamoto, T., McCagg, T., 2006. On the role of language in children's early
200 understanding of others as epistemic beings. *Cognitive Development*, 21(2), 158-173.

201 Moore, C., Pure, K., Furrow, D., 1990. Children's understanding of the modal expression of
202 speaker certainty and uncertainty and its relation to the development of a
203 representational theory of mind. *Child development*, 61(3), 722-730.

204 Nuyts, J. 2001a. Epistemic modality, language, and conceptualization: A cognitive-pragmatic
205 perspective. John Benjamins, Amstredam.

206 Nuyts, J. 2001b. Subjectivity as an evidential dimension in epistemic modal expressions.
207 *Journal of pragmatics*, 33(3), 383-400.

- 208 Öztürk, Ö, Papafragou, A., 2015. The acquisition of epistemic modality: From semantic
209 meaning to pragmatic interpretation. *Language Learning and Development*, 11(3),
210 191-214.
- 211 Öztürk, Ö, Papafragou, A., 2016. The acquisition of evidentiality and source monitoring.
212 *Language Learning and Development*, 12(2), 199-230.
- 213 Palmer, F. R. 2001. *Mood and modality*. Cambridge University Press, Cambridge.
- 214 Papafragou, A. 2006. Epistemic modality and truth conditions. *Lingua*, 116(10), 1688-1702.
- 215 Papafragou, A., Li, P., Choi, Y., Han, C-h., 2007. Evidentiality in language and cognition.
216 *Cognition*, 103(2), 253-299.
- 217 Plungian, V.A. 2001. The place of evidentiality within the universal grammatical space.
218 *Journal of Pragmatics*, 33(3), 349-357.
- 219 Robinson, E. J, Whitcombe, E.L., 2003. Children's suggestibility in relation to their
220 understanding about sources of knowledge. *Child Development*, 74(1), 48-62.
- 221 Saratsli, D., Bartell, S., Papafragou, A., 2020. Cross-linguistic frequency and the learnability
222 of semantics: Artificial language learning studies of evidentiality. *Cognition*, 197,
223 <https://doi.org/10.1016/j.cognition.2020.104194>
- 224 Slobin, D. I., and Aksu, A. A., 1982. Tense, aspect and modality in the use of the Turkish
225 evidential. In: Hopper, P.J. (Ed), *Tense-aspect: Between semantics and pragmatics*,
226 John Benjamins, Amsterdam, pp.185-200.
- 227 Temürcü, C. 2007. A semantic framework for analyzing tense, aspect and mood: an
228 application to the ranges of polysemy of -xr, -dir, -iyor and -Ø in Turkish. PhD Thesis,
229 University of Antwerp.
- 230 Tosun, S., Vaid, J., 2018. Source vs. Stance: On the Relationship between Evidential and
231 Modal Expressions. *Dialogue & Discourse*, 9(1), 128-162.

232 Tura, S. 1986. Dİr in modern Turkish. In Ayhan Aksu-Koç & Eser Erguvanlı-Taylan (Eds),
233 *Proceedings of the Turkish Linguistics Conference in 1984*, pp. 145–158. Istanbul:
234 Boğaziçi University Press.

235 Ünal, E., Papafragou, A., 2020. Relations between language and cognition: evidentiality and
236 sources of knowledge. *Topics in cognitive science*, 12, pp. 115–135.

237 Uzun, N. E. 1998. Türkçede Görünüş/Kip/Zaman Üçlüsü [Aspect/Mood/Tense in Turkish].
238 *Dil Dergisi*, 68, 5-22.

239 Uzundag, B. A., Taşçı, S.S., Küntay, A.C., Aksu-Koç, A., 2018. Functions of Turkish
240 evidentials in early child–caregiver interactions: a growth curve analysis of
241 longitudinal data. *Journal of child language*, 45(4), 878-899.

242 Van der Auwera, J., Plungian, V. A., 1998. Modality’s semantic map. *Linguistic Typology*, 2,
243 79-124.

244 Vilas, B. S. 2020. Do evidential markers always convey epistemic values? A look into three
245 Ibero-Romance reportatives. *Lingua*. <https://doi.org/10.1016/j.lingua.2020.102832>

246 Willett, T. 1988. A cross-linguistic survey of the grammaticization of evidentiality. *Studies in*
247 *language*, 12(1), 51-97.

248 Yavas, F. 1980. On the meaning of the tense and aspect markers in Turkish. (Unpublished
249 PhD dissertation), University of Kansas.

250
251
252
253
254
255