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"I am uncertain" vs "It is uncertain". How linguistic markers of the uncertainty source affect uncertainty communication.

Marie Juanchich * Amélie Gourdon-Kanhukamwe† Miroslav Sirota ‡

Abstract

Two psychological sources of uncertainty bear implications for judgment and decision-making: external uncertainty is seen as stemming from properties of the world, whereas internal uncertainty is seen as stemming from lack of knowledge. The apparent source of uncertainty can be conveyed through linguistic markers, such as the pronoun of probability phrases (e.g., I am uncertain vs. It is uncertain). Here, we investigated whether and when speakers use different pronoun subjects as such linguistic markers (Exp. 1 and 2) and what hearers infer from them (Exp. 3 and 4). Speakers more often described higher probabilities and knowable outcomes with internal probability phrases. In dialogue, speakers mirrored the source of their conversational partner. Markers of the source had a main effect or interacted with the probability conveyed and speaker expertise to shape the judgments and decisions of hearers. For example, experts voicing an internal probability phrase were judged as more knowledgeable than experts using an external probability phrase whereas the result was the opposite for lay speakers. We discuss how these findings inform our understanding of subjective uncertainty and uncertainty communication theories.

Keywords: uncertainty communication, source of uncertainty, subject pronoun, pragmatics

1 Introduction

Uncertainty can seem to stem from a lack of knowledge – and be internal – or from the properties of the environment – and be external (e.g., Kahneman & Tversky, 1982). The apparent source of uncertainty acts as an important determinant of probability judgment and subsequent decision-making (e.g., Brun & Teigen, 1990; Fox & Ülkümen, 2011; Kahneman & Tversky, 1982; Knight, 1921; Ülkümen, Fox & Malle, 2016). Therefore, the use and interpretation of linguistic markers of the source is important to understand. It has been suggested that speakers choose probability phrases bearing specific pragmatic markers to convey the source of their uncertainty (Fox & Ülkümen, 2011; Kahneman & Tversky, 1982; Teigen, 1988b). In this paper, we aimed to provide direct evidence for such a claim. We focused on a subtle property of probability phrases marking the source of uncertainty of the speaker – the subject pronoun of probability phrases (e.g., *I am uncertain* vs. *It is uncertain*). Specifically, we assessed here the determinants of the pronoun subject of probability phrases[1] for speakers (Experiments 1 and 2) and their consequences for recipients' judgments and decision-making (Experiments 3 and 4).

1.1 The source of uncertainty

The traditional theoretical frameworks of perceived uncertainty describe two forms of uncertainty: internal and external uncertainty (Fox & Ülkümen, 2011; Hacking, 1975; Kahneman & Tversky, 1982; Lagnado & Sloman, 2007). Internal uncertainty stems from a lack of personal knowledge. For instance, when one thinks that the Eiffel Tower is *probably* more than 300m high, the uncertainty is internal, and attributable to the level of one's own (lack of) knowledge. External uncertainty stems from uncertainty attributable to processes in the external world (Kahneman & Tversky, 1982), and can be based on frequencies, and hence generate a distributional uncertainty, or based on propensity and hence generate a dispositional uncertainty (also called singular uncertainty). For example, one can bet on a horse based on the number of times she won a race in the past (i.e., distributional external uncertainty), or based on her cur-

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*Department of Psychology, University of Essex, Wivenhoe Park, CO4 3SQ, Colchester, UK. E-mail: m.juanchich@essex.ac.uk.

†Department of Management,Kingston Business School, Kingston University.

‡Department of Psychology, University of Essex.

[1] In the present paper, we have chosen the label *probability* because this concept can be easily compared and mapped on the numerical probability scale. The term *uncertainty* might be considered more adequate than the term *probability* due to its more generic nature, but we have discarded it because the scalar properties of an uncertainty scale are less obvious. For example, being "more uncertain", could mean being closer to 0% or closer to an ignorance prior such as 50% for a dichotomous outcome), whereas an event that is "more probable" is clearly closer to 1. We have chosen the label *phrase* because we focus on a phrase, not on a term or a single word.

rent health record (i.e., dispositional external uncertainty). Kahneman and Tversky acknowledged that, in most cases, uncertainty is a mixture of internal and external sources.

Most empirical work use the terms epistemic and internal interchangeably (Løhre & Teigen, 2016; Robinson, Pendle, Rowley & Beck, 2009; Teigen & Løhre 2017; Volz, Schubotz & Von Cramon, 2004, 2005), apparently making no distinction. However, a more recent account draws a distinction between these categories (Fox & Ülkümen, 2017; Ülkümen et al., 2016). Ülkümen et al. (2016) outlined two variants of subjective uncertainty: epistemic and aleatory. In their model, epistemic uncertainty is characterized by inadequate knowledge or skills and aleatory uncertainty by stochastic behaviors. Epistemic uncertainty usually applies to single cases with binary truth value whereas aleatory uncertainty concerns classes of possible events. Ülkümen et al. (2016) introduced the concepts of internal and external uncertainty as distinct from epistemic and aleatory uncertainty. The internal-external dimension refers to the physical source of uncertainty: is the uncertainty happening in a person's mind (and is internal) or is it "out there" (e.g., uncertainty about the outcome of a future race).

The accounts of uncertainty proposed by Kahneman and Tversky (1982) and Ülkümen et al. (2016) use a similar terminology (internal-external; epistemic-aleatory), but this terminology covers slightly different concepts. For Kahneman and Tversky, internal was synonymous to epistemic whereas Ülkümen and Fox's account treat the internal-external dimension and the aleatory-epistemic dimensions as different and logically independent. For example, they posit that epistemic uncertainty can both be internal and external and that in both cases it would be best conveyed with confidence quantifiers (e.g., *confident*, *certain*, *sure*), whereas internal or external distributional uncertainty would be a form of aleatory uncertainty and would be best conveyed with likelihood quantifiers (e.g., likelihood, probability, chance). The present paper takes no position on whether epistemic and internal are identical. Although the model of Ülkümen and Fox makes sense, we do not address it, because our concern is with the internal/external distinction only.

From a normative point of view, two probabilities, equal in magnitude, should be treated in the same way, regardless of their source. Psychologically, however, this is not the case: the sources of uncertainty has an effect on judgment, decision-making and reasoning. Fox and Ülkümen (2011) suggested that it is because internal and external uncertainties rely on "distinct information, weights and/or processes" (p. 25). Fox and Ülkümen marshalled evidence of such effects from different fields. For example, in hypothetical scenarios, people prefer to bet on a die that will be cast (external uncertainty) rather than on a die that has already been cast without them seeing the outcome (internal uncertainty; Heath & Tversky, 1991; Rothbart & Snyder, 1970). In real life situations, peoples' bet preference is reversed, because they prefer to guess after the die has been thrown (Robinson et al., 2009).

1.2 Linguistic markers of the uncertainty source

Prior research hypothesized that the source of uncertainty can be conveyed through the use of specific words: linguistic markers of the source (Fox & Ülkümen, 2011; Kahneman & Tversky, 1982; Teigen, 1988a). However, only scarce empirical evidence has been accumulated to support this hypothesis (Løhre & Teigen, 2016; Ülkümen et al., 2016). The grammatical subject of probability phrases was the main candidate of such a marker (Kahneman & Tversky, 1982; Løhre & Teigen, 2016). The subject of probability phrases indicate "who" or "what" is uncertain and it is hence logical that first person pronouns would be more characteristic of internal uncertainties, whereas third person neutral pronouns (i.e., it) would be more appropriate to convey external sources of uncertainty.

1.3 When do speakers choose "I" and "it"?

Fox, Ulkumen and Malle (2011) tested the way people choose markers of the source of uncertainty when communicating uncertainty.[2] Fox and colleagues employed a paradigm in which the source of uncertainty was manipulated through the pronoun subject of the probability phrase or the pronoun and a verbal probability associated in both cases with a numerical probability (see respectively Examples 1 and 2):

Example 1.

A: *I am* 70% sure that Bush will be elected US president again

B: *There is* a 70% chance that Bush will be elected US president again

Example 2.

A: Bennie is 60% *sure* that Team A will beat Team B next week.

B: Bob believes there is a 60% *chance* that Team B will beat team A next week.

Fox and Malle (1997) identified a general preference for external probability phrases that can change with contextual factors. Most participants deemed external probability phrases to be more appropriate than internal ones to predict a range of 16 world outcomes. For example, 78% of the participants predicted the outcome of the 1992 American presidential election with an external probability phrase (Example 1, Sentence B). The subject pronoun was shown to relate to the probability conveyed by the speaker. Speakers

[2]Their findings are also cited as Fox and Malle (1997) in Fox and Irwin, (1988).

selected more often an internal probability phrase to convey a higher probability (e.g., "I am X% confident that Minnesota will beat Cincinnati"), whereas they preferred an external probability phrase to convey a low probability (e.g., "I think there is an X% probability that Minnesota will beat Cincinnati"; Study 4). Furthermore, knowledge and expertise of a speaker moderates the use of external phrases. For example, speakers (especially those with higher internal locus of control) selected a confidence term to describe self-related events more often than to describe world events (e.g., "I will go to bed before midnight") (Fox & Malle, 1997; Ülkümen et al., 2016). Interestingly, more knowledgeable speakers were more willing to communicate their uncertainty with confidence terms than less knowledgeable speakers (e.g., Americans predicting the outcome of the American election vs. the German election).

1.4 Effect of the source of uncertainty on hearers

Limited evidence suggests that hearers take linguistic markers of uncertainty into consideration when interpreting uncertainty. When making inferences, the hearers expected a higher probability threshold to be convinced by "I" probability phrases than by "it" probability phrases (Løhre & Teigen, 2016). Participants judged that a 60% external probability was the minimal probability required to advise a patient to take a new treatment, whereas the threshold was about 69% for an internal probability phrase (Løhre & Teigen, 2016). The same pattern was found in different contexts, such as regarding advice in exam revision. However, the effect of the subject on perceived knowledge of the speaker was not consistent across the five experiments. Recipients inferred that speakers uttering internal probability phrases were more knowledgeable than speakers uttering external probability phrases, in one study whereas in two other, the mean differences were not statistically significant (Løhre & Teigen, 2016; Experiment 1 vs. Experiment 3 and 4). When making decisions, the communicated source of uncertainty had a more consistent effect. In Fox and Malle's studies (1997), participants made simple binary choices and read an internal and an external probability phrase describing each option, as in Example 3 below. Most participants (60–70%) preferred the house where the expert described the earthquake risk with an internal probability phrase. The finding was replicated with different vignettes in two other studies.

Example 3.

- A: "I believe there is a 95% chance that Home A will withstand an earthquake of magnitude 7 or less."
- B: "I am 95% sure that Home B will withstand an earthquake of magnitude 7 or less."

Further, recipients' preference for internal probability phrases interacted with the expertise of the speakers: most of the participants preferred to follow an internal probability advice voiced by a professor, whereas most preferred to follow the external probability advice voiced by an undergraduate (Fox & Malle, 1997; Listener – Study 2). This finding was taken as indirectly indicating that the source of uncertainty provided recipients with information about the data that were used or the processes by which uncertainty was assessed: participants were keen to rely on the personal belief of an expert, but would rather rely on a more factually based opinion from a novice (Fox & Malle, 1997).

1.5 Is the subject marking the source of uncertainty? The controversy

Some authors however dispute the possibility that the subject of uncertainty sentences marks the source of uncertainty. Fox and Ülkümen (2017); and Ülkümen et al. (2016) proposed that the subject of probability phrases does not convey the source but the subjectivity of the uncertainty. They tested this hypothesis by showing that a range of numerical probability phrases (e.g., "I am 80% sure" vs. "It is 80% sure") with varying subjects led to variation in subjectivity perception. Participants assessed eight sentences that had four probability quantifiers (e.g., *confidence*, *sure*, *probability*, and *chance*) and that either featured the grammatical subject "I" or "it". This combination however was not always grammatically possible (e.g., *I am 80% probability*), so the phrases for which the sentence did not make sense were complemented with an extra verb and subject (e.g., "I think there is an 80% probability").

Participants judged whether the sentence elicited a more singular or distributional reasoning ("the current signs point to rain tomorrow" was expected to measure singular reasoning and "most of the time there are signs like this it rains the next day" was expected to measure distributional reasoning). The subjectivity was assessed on a scale ranging from 1: "The sentence reflects the speaker's own subjective opinion" to 4: "The sentence reflects objective facts, computation and/or consensus". Results showed that the "I" probability phrases were perceived as more subjective than the "it" ones. Further, the subject interacted with the quantifier type (*chance* and *probability* vs. *confidence* and *sure*) showing that subjectivity also depended on the type of quantifier used. It is also important to note that the subject did not have an effect on the perceived reasoning of the speaker, showing that it did not discriminate between case based reasoning and distributional one.

Teigen and Løhre (2017) disagreed with the proposition that the subject describes the subjectivity of uncertainty and not its source. They agree that the subject is a clue for subjectivity, but they argue that this is because it indicates who or what is being uncertain. The argument for the claim that

TABLE 1: The four accounts describing the function of the subject of probability phrases along with their experimental manipulation.

Accounts	Kahneman and Tversky (1982)	Fox and Ülkümen (2017)	Løhre and Teigen (2016); Teigen and Løhre (2017)	Juanchich et al., 2017 (present paper)
Dimension marked	Internal-external	Subjective-Objective ("voice")	Internal-external	Internal-external
Terminology and definition	Not different from epistemic-aleatory and related to subjectivity	Logically independent from the epistemic-aleatory dimension and from the internal-external dimension	Synonymous to epistemic-aleatory and related to subjectivity.	Synonymous to epistemic-aleatory and related to subjectivity
Manipulation	--	Voice (subject or subject + modal)	Subject (+ numerical probability)*	Subject
Example of manipulation	--	Subj: I'd say there is an 80% probability	Int: I am 57% certain. . .	Int: I am uncertain. . .
		Obj: There is an 80% probability	Ext: It is 45% certain. . .	Ext: It is uncertain. . .

* The example provided shows the average numerical probability provided by participants. Note also that in one of the studies only the subject was manipulated, to assess its effect on probability judgments: "How certain are you – vs. how certain is it – Expe 5a.

the subject of probability phrases marks the source of uncertainty is that the same probability term, such as "uncertain", can be used with different subject pronouns, some of which refer to an object or to nothing (e.g. *it* is uncertain) and some of which refer to a person (e.g., *I* am uncertain). Teigen and Løhre (2017)'s approach is closer to the original proposal by Kahneman and Tversky (1982), where epistemicness and internal uncertainty are not differentiated, and which assumes that internal uncertainty is also more subjective than external uncertainty. The focus of the five papers linking the subject of uncertainty phrases to the variants of uncertainty is summarized in Table 1 to provide an easier grasp of the current landscape.

Thus, the review of the existing frameworks shows a lack of consensus regarding the role of the subject of probability phrases. Existing findings also fall short of providing unambiguous evidence of the role of the subject, because the pronoun manipulation was often confounded with some other features of probability phrases. In Teigen and Løhre (2017), the pronoun was manipulated but participants could associate different numerical probability with it (Experiments 2 and 4), hence confounding the internality with the probability dimension. When the probability did not vary, it was the type and syntactic category of the probability term that varied (e.g., certainty vs. probability, Experiment 3). As suggested by Teigen and Løhre (2017), in Fox and Ülkümen (2017), some phrases presented as featuring a first person pronoun actually featured two grammatical subjects and two uncertainty quantifiers (e.g., "I think there is an 80% probability"), for which the scores were aggregated with simpler sentences "e.g., "I am 80% certain") and compared to a set of simple "it" sentences such as "it is 80% certain" and "there is an 80% probability". This syntactical imbalance is likely to have led to variations in the probability conveyed by the phrases. This variation is in line with research in linguistics where modals are considered as quantifiers of uncertainty (Biber, Finegan, Johansson, Conrad & Leech, 1999). In the only experiment where the pronoun was not confounded with other variables (Teigen & Løhre 2017, Experiment 1), the data indicated that external phrases were judged as being more informative and uttered by more knowledgeable speakers.

1.6 Present research

Prior research indicates that linguistic markers of the source of uncertainty play a role in communicating and interpreting uncertainty phrases. However, we cannot draw firm conclusions regarding the role of the subject as a marker of the source of uncertainty for two reasons. First, the evidence of the role of the subject is mixed (Løhre & Teigen, 2016) and the view that the subject is a marker of the source was recently challenged (Fox & Ülkümen, 2017). Second, the manipulation of the subject used in the prior research might have

been consistently confounded with other factors: the probability conveyed (Fox & Ülkümen, 2017; Løhre & Teigen, 2016), the probability term and its phrasal category (Løhre & Teigen, 2016), and the number of probability terms in the phrase (Fox & Ülkümen, 2017; Ülkümen et al., 2016). Although the confounding effects were sometimes controlled statistically, robust experimental evidence is missing. We propose to provide it here using parsimonious manipulation of the subject while keeping the other dimensions constant. Thus, the current research builds on the previous research but strengthens its contribution by providing additional evidence, while removing possible confounding variables.

In the present manuscript, Experiments 1 and 2 were designed to test whether characteristics associated with the source of uncertainty (e.g., the time of occurrence of an event) predicted the use of a specific pronoun subject (i.e., "I" vs. "it"). We then tested in Experiments 3 and 4 the effect of the subject of probability phrases on recipients' inferences. Hence we propose to test how speakers use "I" and "it" when communicating their uncertainty and how recipients understand probability phrases featuring "I" and "it". Our hypotheses were derived from the model described by Kahneman and Tversky (1982) and supported by data from Løhre and Teigen (2016) showing that the pronoun is a marker of the source of uncertainty on the internal-external continuum. Building on this account, probability phrases featuring a first person pronoun subject are labelled *internal probability phrases* and probability phrases featuring a third person neuter pronoun are labelled *external probability phrases*.

Our materials were composed of the phrases featuring only probability terms derived from the root *certain* (e.g., *very uncertain*, *uncertain*, *not certain*, *very certain*, etc. . .). This was a strategic choice because the lemma *certain* is used with both first and neuter third person pronouns and can be used to convey a large range of probability magnitudes from around 30% to 100% (Bryant & Norman, 1980; Reyna, 1981). Other confidence terms such as *confident*, *think* or *believe* do not offer the same flexibility and can be used only with an animated subject (*Donald* thinks that. . . , *the mouse* believes the cheese is here). Likelihood terms such as *chance* can also convey a range of probabilities but can only be used with inanimate subjects described with dummy pronouns or nominal phrases (e.g., *there* is a chance that it will rain). We also chose not to mix words with numbers because uncertainty words are considered as more natural (Wallsten, Budescu, Zwick & Kemp, 1993), and are expected to be more flexible and to better reflect the way in which people feel uncertain than numbers (Zimmer, 1986).

1.7 Speakers' experiments

The two following experiments tested the factors driving speakers' preferences for communicating internal and external probability phrases. We aimed (1) to replicate past findings of Fox and Malle (1997) regarding the expertise of the speaker and likelihood of the event without confounded variables, (2) to test previously untested theoretical propositions (e.g., that the time location of the uncertain event affects the source of uncertainty; Kahneman & Tversky, 1982), and (3) to explore the effect of conversational dynamics (e.g., agreeing vs. disagreeing) on the preference for internal and external probability phrases.

2 Experiment 1

Given that uncertainty for past outcomes relies more on internal uncertainty, we hypothesized that people would prefer internal probability phrases ("I" probability phrases) when describing past outcomes (vs. present and future outcomes). Further, building on Fox and Malle's (1997) findings, we expected that participants would prefer to communicate higher probabilities with internal phrases, and medium or low probabilities with external phrases. Regarding the conversational context, our assumption was that contradicting a person is face-threatening (Brown & Levinson, 1987), which could be softened by the use of an internal probability phrase (i.e., belonging to the person). In contrast, we expected participants to prefer external probability phrases, as reflecting a more objective reality (i.e., belonging to the world) when confirming a previously voiced opinion to strengthen the effect of the agreement. Finally, given that internal probability phrases can be taken as more subjective, we expected a lower perceived disagreement between two internal probability phrases than between two external probability phrases.

2.1 Method and results

Participants Overall 212 participants from Amazon Mechanical Turk took part in the survey. Amazon Mechanical Turk is considered as a reliable source of participants in psychology (Buhrmester, Kwang & Gosling, 2011; Paolacci, Chandler & Ipeirotis, 2010). Participants' age ranged from 18 to 67 (M = 34, SD = 13), mostly Caucasian Americans (78%), women (57%), employed (70%), with some College education (87%).

Stimuli and Procedure. Participants were informed that the goal of the study was to investigate their preference for internal (*I am not certain*) or external (*It is not certain*) probability phrases in uncertainty communication. All questionnaires contained five selection tasks, presented in random order for each participant, in which participants were instructed to choose the sentence that was most appropriate in a list of two or four sentences.

Task 1: Outcome date. Participants communicated a risk associated with an outcome that happens either in the past, present or future. In a between-subjects design, participants described the risk related to a drug which was either produced in the past (*drugs that were produced in the Nineties*), in the present (*drugs that are produced now*) or in the future (*drugs that will be produced in the future*). Participants communicated the risk by selecting one among four probability phrases. The four phrases resulted from the crossing of two degrees of certainty (i.e., *not certain* and *quite certain*) and two sources of uncertainty (i.e., *I am* vs. *It is*).

- "I am not certain that drugs that were produced in the Nineties were harmless."
- "It is not certain that drugs that were produced in the Nineties were harmless."
- "I am quite certain that drugs that were produced in the Nineties were harmless."
- "It is quite certain that drugs that were produced in the Nineties were harmless."

Participants could choose one of four phrases, two internal and two external. For the analysis, we summed the rate of selection of internal and external phrases.

Task 1 Results. Overall, to describe harmfulness of drugs, participants had a slight preference for internal probability phrases ("I am", 54.7%). They chose internal phrases more often to describe the present risk of harm (63.2%) than to describe the same risk located in the past (52.5%) or in the future (48.4%), but these differences were not statistically significant ($\chi^2(2, N = 212) = 3.17$, $p = .205$, $\phi = .12$).

Task 2: Dice probability scenario. Participants were asked to select a phrase to express a medium or a high probability of a specific outcome in a dice roll: a 50% probable outcome (obtaining a score above 3: 4, 5 or 6), or an 83% probability (obtaining a score higher than 1: 2, 3, 4, 5 or 6). They selected one among four probability phrases taken from Task 1: I am/It is not certain and I am/It is quite certain. The four phrases resulted from the crossing of two degrees of certainty (i.e., *uncertain* and *quite certain*) and two sources of uncertainty (i.e., *I am* vs. *It is*). Participants could choose one of four phrases, two internal and two external. For the analysis, we summed the rate of selection of internal and external phrases.

Task 2 Results. Overall, to describe the probability of obtaining a given score with a die, half of the participants selected an internal probability phrase (48.8%) and the other half selected an external one. In line with our hypothesis, participants selected more internal probability phrases to describe the high probability outcome (60.6%) than to describe the medium probability outcome (39.8%; $\chi^2(1, N = 212) = 9.13$, $p = .003$, $\phi = - - .21$).

Task 3: Contradiction scenario . Participants played the role of Speaker 2 in a dialogue between Speaker 1 and Speaker 2 about the chances of Laura passing her exam. The vignette was designed using a 2 (Contradiction trend: Speaker 2 was less certain vs. more certain) × 2 (Source of uncertainty used by Speaker 1: internal vs. external) between-subjects design. The second speaker (the participant) was either *less* certain (Speaker 1: certain – Speaker 2: not certain) or *more* certain than Speaker 1 (Speaker 1: not certain – Speaker 2: certain). Further, Speaker 1 was either voicing an external or an internal probability phrase. Participants took the role of Speaker 2 and had to choose to use an internal or an external probability phrase to respond to Speaker 1.

In the less certain contradiction condition, participants read the following in the internal source for Speaker 1 condition. The text between brackets shows the equivalent in the external source condition:

Select the response that sounds the most appropriate.

Speaker 1: - "I am [It is] certain that Laura will pass her exam".

Speaker 2:

- "No, it is not certain".
- "No, I am not certain".

In the more certain contradiction condition, participants read the following:

Speaker 1: - "I am [It is] not certain that Laura will pass her exam".

Speaker 2:

- "No, it is certain".
- "No, I am certain".

Task 3: Results. To voice a contradiction, participants overall slightly preferred external probability phrases (54.7%). To test the effect of the direction of the contradiction (more certain vs. less certain) and of the pronoun used by the first speaker, we conducted a logistic regression with the two factors as the independent variable and the source of uncertainty of the phrase chosen as the dependent variable (*I am* vs. *It is*). The regression model predicted correctly 67.5% of the cases ($\chi^2(2, N = 212) = 29.76$, $p < .001$, Cox and Snell $R^2 = .13$).

Participants selected more often an external probability phrase when they were less certain than Speaker 1 (certain → it is uncertain; 58.9%) than when they were more certain than Speaker 1 (uncertain → it is certain; 50%; B($df = 1$) = –0.64, $SE = 0.31$, $p = .038$, OR = 0.53, 95% CI [0.29, 0.96]). Further, participants were more likely to mirror the source of uncertainty selected by their conversational partners (B (*df*

= 1) = 1.55, *SE* = 0.31, $p < .001$, OR = 4.73, 95% CI [2.59, 8.62]). When the first speaker uttered an internal probability phrase, participants were more likely to respond with an internal probability phrase too (64.2%), and similarly, when the first speaker uttered an external probability phrase, participants also responded with an external probability phrase (70.1%).

Task 4: Confirmation scenario. Participants read a dialogue between two conversational partners (Speaker 1 and Speaker 2) discussing the chances of Denis passing his driving license. In a 2 (Probability magnitude: medium vs. high) × 2 (Source of uncertainty: internal vs. external uncertainty) between-subjects design, Speaker 1 conveyed either a medium or high probability (i.e., *not certain* vs. *certain*), using either an internal or an external probability phrase (*I am* vs. *It is*). Participants chose the most appropriate probability phrase for the second conversational partner.

For instance, in the medium probability condition, participants read the following:

Speaker 1: "I am [It is] not certain that Denis will pass his driving licence".
Speaker 2: "Yes, it is not certain"
Speaker 2: "Yes, I am not certain"

In the high probability condition, participants read the following:
Speaker 1: "I am [It is] certain that Denis will pass his driving licence".
Speaker 2: "Yes, it is certain"
Speaker 2: "Yes, I am certain"

Task 4: Results. Overall, to voice a confirmation, participants used more often external probability phrases (61.3%). To test for the main effect of the probability conveyed and of the marker of the source used by Speaker 1, we conducted a logistic regression with the probability magnitude and the source of Speaker 1 as independent variables and the choice of the marker of the source by participants as the dependent variable. The regression model predicted correctly 70.3% of the cases ($\chi^2(2, N = 212) = 30.99$, $p < .001$, Cox and Snell $R^2 = .14$).

As expected, and as in the dice scenario, participants used an internal probability phrase more often to convey a high probability than to convey a medium probability (49.1% vs. 26.5%; B (*df* = 1) = –0.85, *SE* = 0.31, $p = .006$, OR = 0.43, 95% CI [0.23, 0.78]).

Further, as in the contradiction scenario, participants mirrored the source of uncertainty of their conversational partner. When the first speaker used an internal probability phrase, participants preferred an internal probability phrase (55.4%), whereas when the first speaker used an external probability phrase, most participants preferred answering with an external probability phrase (76.6%; B (*df* = 1) = 1.32, *SE* = 0.31, $p < .001$, OR = 3.73, 95% CI [2.05, 6.81]).

Task 5: Level of disagreement between predictions. Participants read two rain forecasts broadcast by two different TV channels. Both forecasts featured the same source of uncertainty but conveyed a different probability magnitude. Participants judged the extent to which the forecasters disagreed on a 5-point Likert scale ranging from 1: *Not at all* to 5: *Completely*.

- "I am [It is] certain that it will rain."
- "I am [It is] uncertain that it will rain."

Task 5: Results. Overall, participants rated that the two weather forecasters, who made different probabilistic forecasts using the same marker of the source, disagreed (*M* = 3.66, *SD* = 1.16 on a 5-point scale ranging from *Not at all* to C*ompletely*). However, the markers of the source in the probability phrases did not have an effect on participants' perception of the level of disagreement between the weather forecasters ($M_{\text{Internal}} = 3.70$, *SD* = 1.22 and $M_{\text{External}} = 3.64$, *SD* = 1.12, $t(210) = 0.37$, $p = .710$, $d = 0.05$).

2.2 Discussion

In the five scenarios, participants chose a different pronoun subject as a function of the probability of occurrence of the outcome and the conversational situation. Participants used more internal probability phrases to express high probabilities than to express medium probabilities. The effect of the probability magnitude on the preference for specific phrase subjects does not exactly match the view that the pronoun is a marker of the source or subjectivity, given that any dice outcome could be considered as equally objective and stemming from aleatory uncertainty.

Participants did not have different subject preferences for outcomes that are typically frequency based and considered objective (e.g., the outcome of a dice roll) and outcomes that are less distributional and more subjective (whether drugs can be harmful) – the average was around 50% for both. This does not support the hypothesis that the subject marks the source of uncertainty nor the hypothesis that third person pronouns mark objectivity (Fox & Ülkümen, 2017). Interestingly, when set in a conversation, participants preferred to convey the same source of uncertainty as their conversational partners, whether they agreed with or contradicted that person.

Our data did not show that the timing of an outcome would affect the preference of markers of the source of uncertainty. This appears to contrast with previous findings that the time of occurrence of an outcome is an important factor in determining the source of uncertainty (Brun & Teigen, 1990; Kahneman & Tversky, 1982). Our result complements the

findings of Ülkümen et al. (2016) who found that future outcomes were more often described with likelihood quantifiers, albeit not after controlling for other aspects of the sentence (e.g., control, source). The next experiment aimed to further look into the time of occurrence of an outcome in conjunction with the level of knowledge regarding this outcome.

3 Experiment 2

We propose that knowledge is a key variable to explain the effect of timing observed in past research (Brun & Teigen, 1990; Kahneman & Tversky, 1982) and the lack of effect observed in Experiment 1. We propose that the knowability of an outcome – whether one can assess whether it will occur or not – is often confounded with the timing of an event – predicts the preference for "I" vs. "it" sentences.

Uncertainty about past outcomes stems from a lack of personal knowledge because whether the outcome has occurred or not is a fact that at least some people *know*. Uncertainty about future outcomes may stem from a lack of knowledge but also from stochastic properties of the world such that nobody knows *for sure* what will happen. In our drug scenario in Experiment 1, participants may not have experienced variations in perceived knowledge regarding the outcome whether it was past, present or future. Indeed, the time when the drug could be dangerous and the degree of knowledge of participants regarding drugs may not have been connected (e.g., strong knowledge of the dangerousness of past drugs vs. lack of knowledge of the dangerousness of future drugs). The timing of an event and its knowability are independent dimensions that are negatively correlated (more knowledge about past events) for some outcomes but not for some others. There are instances where the opposite relationship exists: we sometimes lack knowledge about past outcomes (e.g., whether Shakespeare has or has not written King Lear) and we can be very knowledgeable about future outcomes (e.g., when and where the moon will rise in a week).

We propose that one of the mechanisms underlying the preference for internal or external probability phrases relies on the knowledge of the outcome and the instrumentality of this knowledge to assess uncertainty. Building on the "knowability" dimensions proposed by Chow and Sarin (2002), we investigated the preference for internal and external probability phrases for known, predictable and unknowable outcomes. We expected that participants would use more internal probability phrases for known or predictable outcomes than for unknown outcomes.

3.1 Method

Participants. One hundred and thirty-one students at a Norwegian university took part in the survey. The socio-demographic characteristics of this group were not recorded.

Materials and Procedure. We selected 10 outcomes (listed below) falling into three categories: *known* outcomes*, predictable* outcomes and *unknowable* outcomes*. Known* outcomes were defined as either past agreed outcomes (e.g., the UN was founded after the war) or current realities (e.g., Sweden won the last match against Denmark). For *known outcomes*, uncertainty is deemed only internal because a quick search would enable people to reach certainty. *Predictable* outcomes were defined as future outcomes for which uncertainty is both internal and external: knowledge about the world helps to reduce uncertainty but cannot bring certainty. *Unknowable* outcomes were defined as past, present or future outcomes that are unknowable for certain, given the state of knowledge of humanity. For those outcomes, there is no identified point in time where the outcome will be fully certain. Uncertainty for those outcomes relies further on external uncertainty because nobody has a true knowledge of whether an event has happened or will happen.

For each outcome, participants selected one of two probability phrases that appeared most natural to them between the phrase featuring "I am" and the one featuring "It is". If they perceived both phrases to be natural, participants were asked to select the one that sounded most like a genuine quotation.

Participants selected a probability phrase for four known outcomes, four predictable outcomes and two unknowable outcomes. The outcomes were described with medium or high verbal probabilities which are presented below between brackets. The four known outcomes were composed of two historical events and two geographical facts: "The UN was founded after the war" (*almost certain*), "Sweden won their last match against Denmark" (*uncertain*), "Lithuania is South of Latvia" (*uncertain*), "Toulouse is in France" (*certain*). The four predictable outcomes were all located in the future: "Spain will be part of the 2012 European Championships" (*quite certain*)[3], "Sweden will win their next match against Denmark" (*uncertain*), "What I will do tomorrow" (*not certain*), "Hans will accept the offer" (*not certain*). The two unknowable outcomes were: "There is life on other planets" (*quite certain*) and "Robin Hood has actually lived" (*not certain*). Participants then completed an additional task which is not reported here. The order of the question was fixed as follows: UN, Spain, Sweden past match, Sweden future match, life on other planets, Robin Hood, Lithuania, Toulouse, What I will do and What Hans will do. The survey was in Norwegian and is presented in English in the Appendix.

[3]The data was collected in 2011, before participants could know who would take part in the 2012 European Championships.

TABLE 2: Preference for internal and external probability phrases (in %) along with a binomial test with a value of 50%. "I" is a marker of internal source of uncertainty and "It" is a marker of external source of uncertainty.

		Source of uncertainty		
Knowledge	Outcome	I am	It is	Binomial test
Known (past/current)	UN – Almost certain	**92.4**	7.6	$p < .001$
	Sweden – Uncertain	**96.2**	3.8	$p < .001$
	Lithuania – Uncertain	**95.4**	4.6	$p < .001$
	Toulouse – Certain	**68.7**	31.3	$p < .001$
	Total knowable	**88.2**	11.8	
Predictable (future)	Spain - Quite certain	**57.3**	42.7	$p = .115$
	Sweden – Uncertain	37.7	**62.3**	$p = .006$
	What I will do - Not certain	**95.4**	4.6	$p < .001$
	What Hans will do - Not certain	**65.6**	34.4	$p < .001$
	Total predictable	**64.0**	36.0	
Unknowable	Life on other planets - Quite certain	48.9	**51.1**	$p = .861$
	Robin Hood - Not certain	26.0	**74.0**	$p < .001$
	Total unknowable	37.4	**62.6**	
	Grand Total	**63.2**	46.8	

3.2 Results and discussion

As expected, participants selected more often an internal probability phrase for known and predictable outcomes than for unknowable outcomes. To describe the four knowable outcomes, a large majority of participants selected an internal probability phrase as more natural than an external one (88%, see Table 2). For predictable outcomes, the preference for an internal or external source of uncertainty was less strong, with three phrases out of four where participants preferred the internal version, forming overall a smaller majority (64%). Regarding the future outcomes, one can also see that the preference for the first person pronoun subject was stronger when the statement was about the speaker and featured a first person pronoun. The only item for which "it" was preferred among the future outcome was for the future results of a Swedish football match. This preference may have been the result of a contrast between this question and the previous one that focused on the past result of the Swedish team and for which participants largely preferred the "I" prediction. This echoes findings of Experiment 1, showing a mirroring effect in conversation. Finally, for unknowable outcomes (i.e., life on other planets and Robin Hood), participants preferred external probability phrases, although this preference was significantly different from 50% only for the Robin Hood sentence.

We computed a summation score of preference for internal probability phrases within each outcome category (known, predictable and unknowable outcomes), and we normalized this score by the total number of sentences within the outcome category. Hence, each participant had a score ranging from 0 to 1 for known, predictable and unknowable outcomes, 0 representing a systematic preference for external probability phrases and 1 a systematic preference for internal probability phrases. We entered these three scores in a within-subject ("repeated measures") variance analysis with the type of outcome as independent variable and the internal probability phrase score as dependent. The type of outcome had a main effect on the preference for internal probability phrases ($F(2,260) = 129.29$, $p < .001$, $\eta_p^2 = .50$). Participants exhibited a stronger preference for internal probability phrases for knowable outcomes than for predictable outcomes and unknowable outcomes ($M_{\text{Diff}} = 0.32$; 95% *CI* [0.26, 0.38], $p < .001$; and $M_{\text{Diff}} = 0.51$, *CI* [0.43, 0.59], $p < .001$), respectively, and a stronger preference for internal probability phrases for predictable outcomes than for unknowable outcomes ($M_{\text{Diff}} = 0.19$, $p < .001$, CI [0.10, 0.27], pairwise comparisons with Bonferroni adjustment).

3.3 Interim discussion

Overall, the two experiments presented here complement and extend the current literature in several respects. First, the knowability of an outcome is a good predictor of the

preference for internal and external probability phrases. Participants preferred strongly internal phrases for known outcomes – defined as established historical or geographical facts – whereas this preference was less strong for predictable outcomes and even the opposite for unknowable outcomes. Second, speakers have a slight preference for internal probability phrases (e.g., "I am not certain"). However, this preference depended – in addition to the knowability – on the likelihood of occurrence of the outcome as well as the conversational context. This general internal preference and the role of the probability magnitude replicates prior findings (Fox & Malle, 1997). Third, and more novel, participants tended to choose more often a probability phrase that mirrored the source of uncertainty used by their conversational partner (conversation vignettes in Experiment 1 and Personal future action phrase in Experiment 2).

Furthermore, results of Experiment 2 do not support the hypothesis that the pronoun subject was chosen to mark the subjectivity of the speaker (Fox & Ülkümen, 2017; Ülkümen et al., 2016). Indeed, outcomes characterized by the least amount of data or a lack of consensus and whose probability was hence subjective (e.g., life on other planets), were more often described with a third person neuter pronoun, which was posited to mark objectivity. In contrast, outcomes for which facts existed or are consensually agreed and whose probability was hence more objective were mainly described with first person pronoun phrases. These results are more in line with the hypothesis that the subject of uncertainty phrases is primarily a marker of the source of uncertainty (Teigen & Løhre 2017).

Given that speakers use contextual cues to decide whether it is best to say "I am uncertain" or "It is uncertain", then we can assume that the pronoun subject carries pragmatic implications for recipients. The possibility that probability phrases convey pragmatic meanings (e.g., about the state of knowledge of speakers, about their intentions) is not novel and falls within a literature strand positing that probability phrases convey more than a vague probability magnitude to recipients (Moxey & Sanford, 2000; Teigen & Brun, 2003). More generally, the hypothesis that language has a strong pragmatic layer fits a functional approach of language (Fiedler, 2008).

3.4 Impact of linguistic markers of uncertainty sources on hearers

There is little and mixed evidence about what recipients infer from linguistic markers of the source of uncertainty. For example, in one article, recipients inferred that speakers uttering internal probability phrases were more knowledgeable than speakers uttering external probability phrases in one study out of three; in the remaining two studies, the mean differences were not statistically significant (Løhre & Teigen, 2016; Experiment 1 vs. Experiment 3 and 4). Another example of mixed results is related to the inference about the personal interest of the speaker: in one study out of two, a first person pronoun was taken as a cue of increased personal interest in comparison with a neuter subject pronoun (Experiment 3 vs. Experiment 4).

Previous research indicated that recipients may draw some inferences from the use of internal and external probability phrases such as speakers' levels of knowledge or the nature of the evidence they used (Fox & Malle, 1997; Løhre & Teigen, 2016; Ülkümen et al., 2016). However, the pattern of inferences drawn in previous research was not consistent. In Experiments 3 and 4, we assess the impact of internal and external probability phrases on the recipients' inferences and their decisions. Experiments 3 and 4 aim to replicate and broaden previous findings by showing that linguistic markers of the source of uncertainty affect the judgments and decisions of recipients (Fox & Malle, 1997; Løhre & Teigen, 2016; Ülkümen et al., 2016).

4 Experiment 3

We hypothesized that markers of the source of uncertainty used in probability phrases would affect the recipients' judgments about the speaker as well as their subsequent decisions. This expectation is consistent with prior research (Løhre & Teigen, 2016). Specifically, we expected that recipients would perceive speakers uttering an external probability phrase as more knowledgeable and less supporting of the outcome. We expected that recipients would interpret external probability phrases as being based on outcome frequencies and as being more informative than internal probability phrases. Finally, we expected that recipients would be more likely to use external probability phrases to guide hypothetical bets than internal probability phrases.

4.1 Method

Participants. Overall 256 native French speakers took part in the survey, recruited through a pool of participants interested in cognition (RISC – Réseau d'Information Sur la Cognition). Participants were between 19 and 69 years old (M = 30.64, SD = 10.47) and 66% of them were women.

Design. Hypotheses were tested in a 2 (Source of uncertainty: internal vs. external) × 3 (Probability magnitude: low, medium, high) mixed-design. The source of uncertainty was manipulated between-subjects by the subject pronoun used in the prediction, either "I" or "It". The probability magnitude was manipulated within-subject using three different verbal probabilities: *very uncertain*, *not certain* and *almost certain*.

TABLE 3: Internal and external probability phrases used in Experiments 3 and 4.

Probability	Probability phrase
Low	"I am [It is] very uncertain that VfL Bochum will win against Hoffenheim."
Moderate	"I am [It is] not certain that Wolfsburg will win against FSV Mayence."
High	"I am [It is] almost certain that Borussia Dortmund will win against the Bayer Leverkusen."

Materials and procedure. Participants took part in the questionnaire on the Internet (using the platform LimeSurvey®). Participants were asked to randomly select one of two web-links to participate: the first link led to the questionnaire featuring internal probability phrases and the second link led to the questionnaire featuring external probability phrases. Participants were instructed to pay attention before validating their answers, as they could not go back.

Participants judged three football game predictions made by Leo (a French person randomly selected as part of a survey on football knowledge). The three predictions featured different probability magnitudes and focused on different hypothetical matches in the German league: Match 1, VfL Bochum vs. Hoffenheim; Match 2, Wolfsburg vs. FSV Mayence; Match 3, Borussia Dortmund vs. the Bayer Leverkusen. The same pairs were used for all participants. The first team of each pair was predicted as having a low, moderate and high probability of winning, respectively. The probability magnitude of winning was manipulated by using a verbal probability reflecting a low, moderate or high probability as shown in Table 3.

The order of presentation of the probability phrases was either from low to high probability magnitude or from high to low. The pairs of teams and their associated probabilities of wining were selected randomly in the German Champions' league.

For each football game prediction, participants answered five questions. Participants assessed the speaker's knowledge of the two teams and whether he supported the team concerned with the prediction. Participants also assessed the extent to which the prediction was based on statistical information and informativeness. Finally, participants assessed their willingness to use the information if they were to bet on the game. Questions were presented in a fixed order: knowledge of the speaker, prediction based on statistics, use of the prediction if betting, informativeness of the prediction, and team preference of the speaker. Participants provided their judgments on 5-point Likert scales. On a new webpage, as a manipulation check for the probability manipulation, participants were subsequently reminded of each prediction and assessed the probability conveyed by Leo on an 11-point scale ranging from 0: "Leo is certain that the team will not win" to 10: "Leo is certain that the team will win". Finally, participants provided their age, gender, job, and mother tongue, and their subjective level of expertise in the German Champions Football League (scale from 1: *No knowledge at all* to 5: *Expert about this Championship*).

4.2 Results

Manipulation checks. The expertise of participants in the German league was relatively low (M = 1.21, SD = 0.60, on a scale ranging from 1 to 5) and did not affect the dependent variables nor interact with the independent variables. The expertise was therefore not included in the analyses described below.

We checked whether the manipulation of the probability magnitude was effective by comparing participants' probability perception in the different probability magnitude conditions. Further, we tested whether the source of uncertainty ("I" vs. "It") affected the probability perceived by participants, as this could suggest that the effect of the source could be indirect through probability perception. We conducted a mixed design variance analysis with probability magnitude and source as independent variables and probability perception as dependent variable. The probability magnitude manipulation was successful. The probability perception was low for *very uncertain* predictions 3.22 (SD = 2.48), moderate for *not certain* 4.34 (SD = 1.71) and high for *almost certain* 7.67 (SD = 1.43; 11-point scale ranging from *certain that the team will not win* to *certain that the team will win*; and $F(1.67,425.12) = 375.99$, $p < .001$, $\eta_p^2 = .60$). Furthermore, and importantly, the source of uncertainty did not have a main effect or an interaction effect with probability magnitude on probability perception, $Fs < 1$. Therefore, internal and external probability phrases were perceived as conveying the same levels of probability.

Effects of source of uncertainty and probability magnitude. Figure 1 illustrates all results. For each of the dependent variables (other than probability), we asked whether the mean response was dependent on the source ("I" vs. "It") with a between-group t-test. We also assessed the effect of probability on each variable by subtracting the low-probability case from the high-probability case, for each subject. All dependent variables except the variable Use of statistics yielded higher ratings with higher probabilities ($p < .001$ for each of the four).

Speakers were judged as more knowledgeable when they used an external probability phrase ("It") than when they

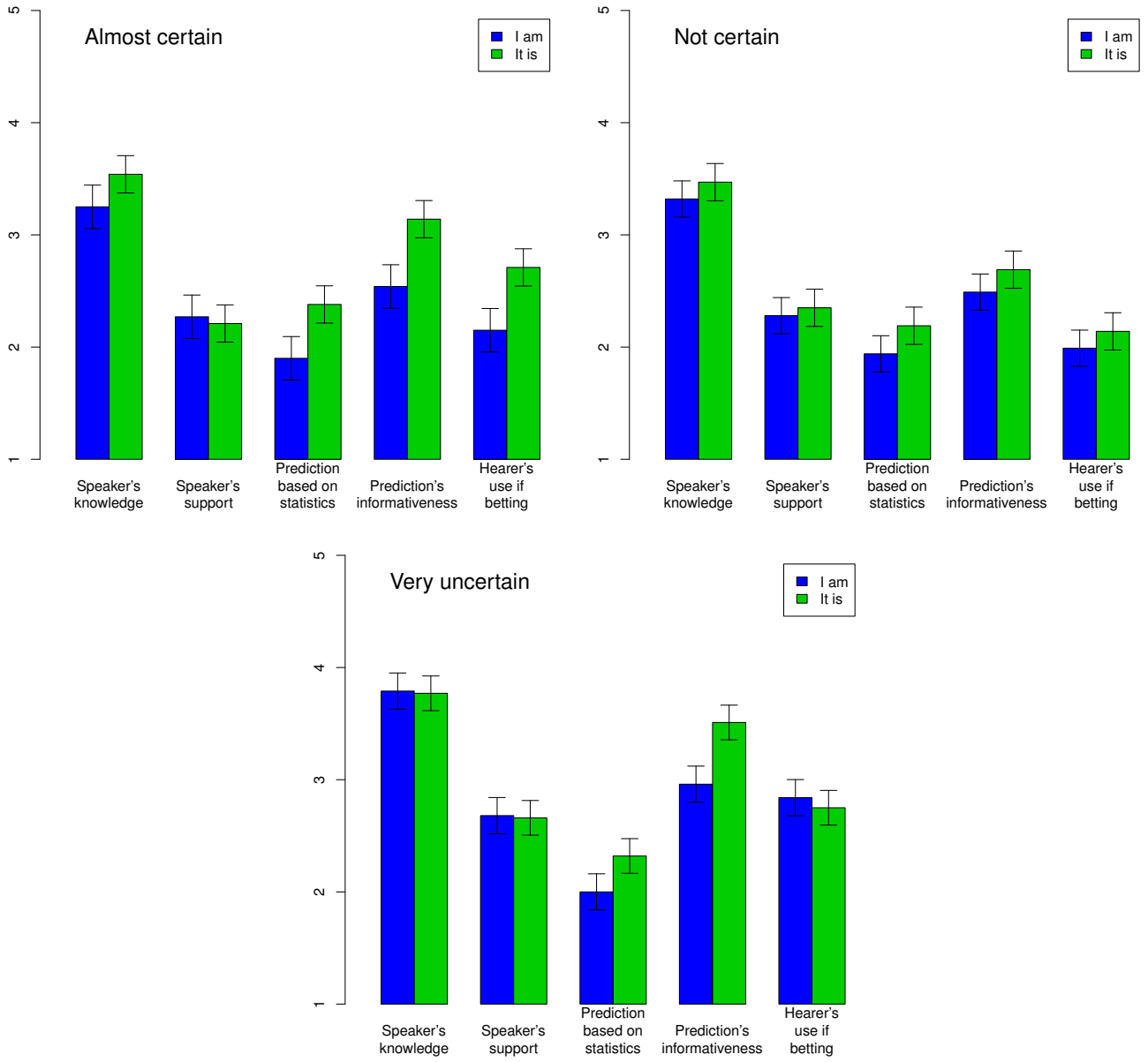

FIGURE 1: Mean judgments provided for three football game predictions as a function of the sentence subject ("I" vs. "it"), Experiment 3. Judgments focus on the speaker's knowledge and support, on the data used in the prediction, the prediction informativeness and about participants' willingness to use the prediction in betting. Error bars are 95% confidence intervals.

Note: All judgments used a 5-point scale ranging from 1: *Not at all* to 5: *Completely*. High probability of winning: Borussia Dortmund vs. the Bayer Leverkusen; Moderate probability of winning: Wolfsburg vs. FSV Mayence and low probability of winning: VfL Bochum vs. Hoffenheim.

used an internal phrase, but this difference was not significant (t (240.15) = 1.29, n.s., Welch corrected). But the high-low probability difference also differed as a function of source (t (253.45) = 2.25, p = .025). As is apparent in Figure 1, the effect of source was present only for the two highest probabilities. The resulte for usefulness in betting were similar (t (247.71) = 1.75 for the main effect, t (226.89) = 4.03, $p < .001$, for the high-low difference).

The source did not make a difference in terms of team support. External probability phrases were perceived to be more often based on statistics (t (216.5) = 2.65, p = .001) and to be more informative(t (253.14) = 3.62, $p < .001$).

The results of the present experiment illustrate that recipients can draw inferences from the pronoun subject used in a prediction. Participants use the grammatical subjects of probability phrases to draw inferences about the prediction

and its speaker. These inferences are consistent with the assumption that the grammatical subject of a probability phrase is a marker of a speaker's source of uncertainty and that the source of uncertainty conveyed has psychological implications for the hearer. For example, participants perceived an external probability phrase as more statistically based and more informative than internal probability phrases.

These results highlight that participants infer that speakers using a neuter third person pronoun rely more on an external source of uncertainty. The sentence subject was also related to perception of subjectivity, but this effect was dependent on the strength of the belief conveyed by the speaker. The judgments of informativeness and willingness to use in betting depended on both the grammatical subject and the probability conveyed. In the next experiment, we assessed the role of the expertise of the speaker by manipulating it. Further, we improved the design by randomizing the order of the predictions and of the questions.

5 Experiment 4

Experiment 4 tests further the effect of the source of uncertainty communicated on judgment and decision-making. We replicated the uncertainty source manipulation and extended Experiment 3 by manipulating the expertise of the speaker. In this experiment, participants drew inferences about the perceived knowledge of the speaker, his perceived support and the kind of information that the prediction relies on (e.g., information about past matches). In addition, participants focused on the perceived processes of forming predictions (e.g., intuition), assessed judgments about the speaker's attitude toward the betting situation (e.g., encouraging or not) and focused on potential consequences for the speaker (e.g., responsibility, correctness).

We derived hypotheses based on existing empirical evidence showing that participants preferred to use internal probability phrases made by experts. This was related with the perception that experts "took responsibility" in their prediction by using a first person pronoun. In contrast, participants preferred to use the external probability phrases of novices, which they felt reflected a greater responsibility than internal probability phrases (Fox & Malle, 1997). We hypothesized that novice speakers uttering an external probability phrase would be judged as more knowledgeable, less supportive of the team and less encouraging, but also less wrong and blameworthy if the team lost, than speakers uttering internal probability phrases. We expected the results to be mirrored for expert speakers.

5.1 Method

Participants. Overall 81 Psychology students from Birmingham University took part in the survey, mostly female (80%). Participants' ages ranged from 18 to 24 (M = 18.94, SD = 1.03).

Design. We employed a 2 (Uncertainty source: internal vs. external) × 2 (Expertise: novice vs. expert) × 2 (Probability magnitude: very uncertain vs. almost certain) mixed design. The first two factors were manipulated between-subjects, whereas probability magnitude was manipulated within-subject. Thus, each participant read two out of eight possible predictions.

Materials and procedure. The source of uncertainty was manipulated as in Experiment 3 (i.e., *I am* or *It is* preceded the prediction). Expertise was manipulated by presenting the speaker (i.e., Miro) as having either a very limited experience of the league (novice speaker; i.e., "He has watched some of the champion league matches 5 years ago and has never read any magazines on football"), or an extensive experience (expert speaker; i.e., "He has watched all the champion league matches of the last 5 years and he reads different magazines on football"). Each participant assessed two predictions, one conveying a low probability (*It is [I am] very uncertain that FC Nitra will win against FC Senec*) and one conveying a high probability (*It is [I am] almost certain that ZTS Dubnica will win against Spartak Trnava*). The order of presentation of the two predictions was randomized.

After reading Miro's prediction, participants judged to what extent: (1) Miro has knowledge about these teams; (2) Miro is supporting FC Nitra; (3) Miro would be wrong in the case where FC Nitra does not win against FC Senec; (4) Miro could be blamed if one bets and loses; (5) the prediction could be seen as an encouragement to bet on FC Nitra; (6) the prediction relies on the results of previous matches; (7) the prediction relies on intuition. Then, participants assessed whether they would bet on the team in question. The order of presentation of the questions was randomized for each participant. All the judgments were provided on a 5-point Likert scale ranging from 1: *Not at all*, to 5: *Very much*. Finally, participants assessed the probability conveyed by Miro for the two predictions. Participants were given the two predictions that they had judged, finished by "because". The answer to this question was not analysed as part of the present paper. Finally, participants provided their socio-demographic details.

5.2 Results

Manipulation check. We tested whether the manipulation of the probability was effective and whether the source of uncertainty and the speaker's expertise affected the perceived probability of participants, as this could suggest that the effects of the independent variables were due to an indirect effect through probability perception. We conducted a

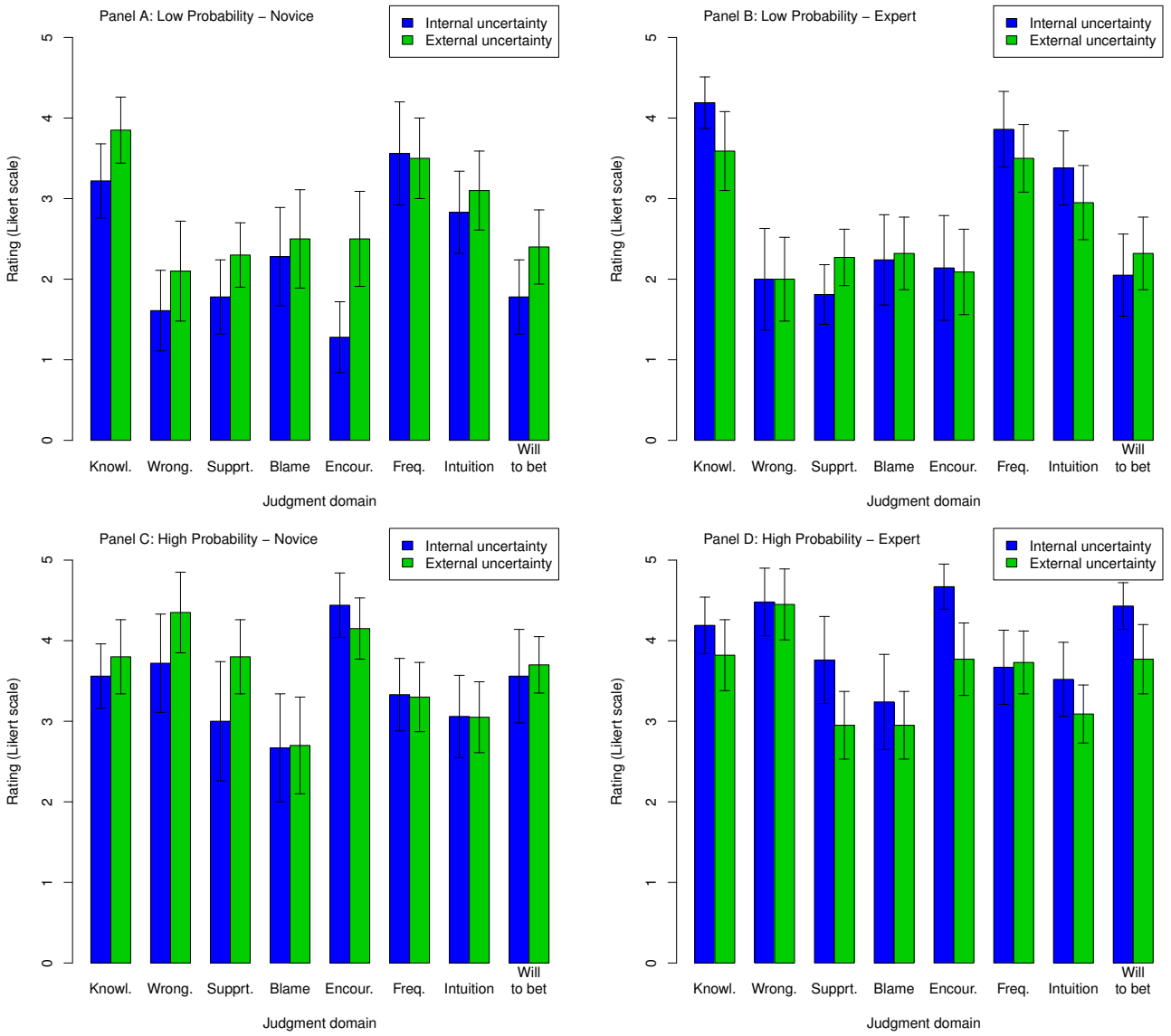

FIGURE 2: Effect of expertise and source of uncertainty on judgments about recipients' inferences for low and high probability phrases (N = 81), Experiment 4. Judgments were given on a 5-point Likert scale ranging from 1: *Not at all* to 5: *Completely*. Error bars are 95% confidence intervals.

mixed design variance analysis with probability magnitude, source, and expertise as independent variables and probability perception as dependent variable. The probability magnitude manipulation was successful: participants perceived the probability phrase featuring *almost certain* as conveying a high probability (M = 7.67, SD = 1.43; and *very uncertain* as conveying a low probability (M = 3.22, SD = 2.48), $F(1,77) = 266.47$, $p < .001$, $\eta_p^2 = .78$). Furthermore, and importantly, the source of uncertainty and the expertise of the speaker did not have a main effect or an interaction effect on probability perception, $Fs < 1$. Therefore, internal and external probability phrases were perceived as conveying the same level of probability.

Effects of the uncertainty source, expertise and probability magnitude. Figure 2 shows the mean responses as a function of the source of uncertainty, probability conveyed and expertise of the speaker. We analyzed the effects on each response using t-tests as in Experiment 3. The probability manipulation affected all measures at $p < .001$ except for Frequency, Intuition, and Knowledge, where effects were not significant even at $p < .05$. Aside from this effect, the Wrong measure was not affected by any manipulation, so is not discussed further. Likewise, the source manipulation ("I" vs. "It") and the expertise manipulation did not have an overall main effect on any measure (although Willingness to

bet and Know were almost significantly higher with higher expertise, $p = .07$ for both).

The main result of interest is that the interaction between expertise and source was significant for Encouragement, Support, and Know (with respective p-values of .011, .026, and .011) and almost significant for Willingness to bet (p=.0723). In all cases, ratings were higher when experts used "I" and when non-experts used "It". The interaction effects reflect that participants judged an expert uttering an internal probability phrase as more knowledgeable and more encouraging than an expert uttering an external probability phrase, whereas they considered the opposite was true of a novice: a non-expert using an internal probability phrase rather than an external one is seen as more knowledgeable and more encouraging. Similarly, experts were perceived to be more supportive of the team when producing an internal probability phrase than when producing an external probability phrase, whereas non-experts were judged more supportive when uttering an external probability phrase. Finally, participants were keener to bet on the team when experts used an internal probability phrase than an external one, but were keener to bet on an external prediction made by a novice.[4]

Table 4 offers a bird's eye view of the results of Experiments 3 and 4.[5] The inferences drawn from the subject pronoun are consistent with the hypothesis that it reflects the source. The effect of the subject varied as a function of the probability conveyed and of the level of expertise of the speaker. The results show that recipients use the phrase subject and the expertise of the speaker together to draw inferences about the knowledge and attitude of the speaker, as well as to assess the persuasiveness of the message. Therefore, to maximize communication impact, experts should use internal markers of uncertainty (*I am* certain that...), whereas novices should use external linguistic markers of uncertainty.

TABLE 4: Summary of the effect of the main factors: source of uncertainty, probability magnitude and expertise on judgments in Experiments 3 (2 Source * 3 Probability, mixed-design) and 4 (2 Source * 2 Expertise * 2 Probability, mixed-design).

	Source	Source * Probability	Source * Expertise
Experiment 3			
Knowledge	No	Yes	--
Support	No	No	--
Based on statistics	Yes	No	--
Informativeness	Yes	No	--
Use if betting	No	Yes	--
Experiment 4			
Knowledge	No	No	Yes
Support	No	No	Yes
Wrongness	No	No	No
Blame	No	No	No
Encouragement	No	Yes	Yes
Frequency	No	No	No
Intuition	No	No	No
Willingness to bet	No	Yes	Almost

6 General discussion

Thirty-four years ago, Kahneman and Tversky (1982) described four variants of uncertainty and posited that those variants were connected with specific lexical preferences in uncertainty communication. They provided tentative definitions of the variants of uncertainty and some compelling examples of linguistic markers of the source (e.g., *the* probability is vs. *my* probability is. . .). It is only recently that the role of the source of uncertainty and its representation in language has been more systematically tested (Fox & Ülkümen, 2017; Løhre & Teigen, 2016; Ülkümen et al., 2016). However, there is currently a debate over what is actually marking the source of uncertainty in uncertainty language. Researchers have used the examples provided by Kahneman and Tversky (1982) differently: some have focused on the subject of the phrase and some on the probability term being used. Unsurprisingly, the theoretical account of researchers focusing on the probability terms posited that only the probability term was a marker of the source, and that the subject was a marker of subjectivity (Fox & Ülkümen, 2017). In contrast, the account of researchers focusing on the sentence subject posited that the subject was a better marker of the source (Teigen & Løhre 2017). The work presented here assumed that the pronoun subject of probability phrases was used as a marker of the source of uncertainty as hypothesised by Kahneman and Tversky (1982) and substantiated by Løhre & Teigen (2016). Furthermore, this account also posits a positive relationship between internal-external source of uncertainty and the level of objectivity of a speaker. We aimed to test the determinants and consequences of the use of pronoun subjects as markers of the source of uncertainty.

Our results indicate that speakers use pronouns to mark the source of the uncertainty. They also indirectly indicate that speakers use pronouns primarily to mark the subjectivity of the source of their uncertainty, but for recipients, the pronoun may be used to infer both the source of un-

[4]This interaction for Support was significantly greater when probability was high ($p = .016$ for this "triple interaction") but was not significant for any other measure.

[5]As shown in the table but not mentioned before, Encouragement and Willingness to bet in Experiment 4 were affected by the probability manipulation (p-values of .001 and .042, respectively).

certainty and the subjectivity of the speaker. For example, speakers selected more often the "I" prediction for more knowable outcomes (more objective), whereas unknowable outcomes (subjective in nature) were more often described with the neuter pronoun "It" (Experiment 2). In contrast, in the recipients' studies, both the source of uncertainty and the subjectivity of the speaker could explain our pattern of results. For example, we could describe the results of Experiment 4 as follows: "experts providing prediction based on internal knowledge are more convincing than experts providing predictions based on external information", but also as follows: "experts providing a subjective prediction are more convincing than experts providing an objective prediction". Future research designed to test the different accounts of uncertainty markers would provide more solid evidence.

Results also point to new determinants and consequences of the sentence subject. In terms of determinants of sentence subjects, we found that circumstantial factors, such as the probability of occurrence of the outcome or the subject used by a conversational partner predicted the preference for a specific pronoun subject (Experiment 1). Interestingly, those factors were not related to the source of uncertainty, nor to its subjectivity. Regarding novel effects of the sentence subject, we found that the sentence subject affected people's willingness to use the prediction if betting (Experiments 3 and 4). This indicates that the sentence subject may also be a pragmatic signal of the course of action recommended by the speaker. In line with this argument, participants also felt that the sentence subject was related to the level of encouragement to bet of the speaker (Experiment 4). Altogether, these findings indicate that the sentence subject has several semantic and pragmatic functions: it is not only used by recipients to infer the source of uncertainty, or the subjectivity of the speaker.

6.1 Theoretical update for linguistic markers of the source of uncertainty

Our approach to uncertainty language is that it is like a tool box from which speakers draw different tools that they use in a creative and goal oriented way. Building on previous accounts of the language of uncertainty (Fox & Ülkümen, 2017; Teigen & Løhre 2017) and the present results, we propose that the subject and the probability term mark the same qualitative information – the source of uncertainty – and that they combine to create different quantitative levels of internality or externality. In line with this account, data suggest that the nature of the subject and the type of probability term have been shown to correlate in a corpus of natural language (Ülkümen et al., 2016). The rules for combining the added value of different markers of the source could be simple, such as a basic addition (internal pronoun + internal term = very internal) or could be more driven by the subject, as suggested by (Løhre & Teigen, 2016; Teigen & Løhre 2017).

We also propose that linguistic markers of the source have consequences for the subjectivity perception of recipients. Our position is that recipients infer the level of subjectivity of speakers based on their source of uncertainty, together with the characteristics of the context (e.g., who is speaking, in which context, about which outcome). This model emphasizes the importance of the context, similarly to the model proposed by Fox and Irwin (1998). In our model, the source of uncertainty and the subjectivity are not psychologically independent given that the source of uncertainty is a determinant of subjectivity. The interaction effects found in Experiment 1 (with probability conveyed) and in Experiment 4 (with probability conveyed and the expertise of the speaker) support the view that the sentence subject of probability phrases does not translate directly into a level of subjectivity.

Finally, our account posits that the source is a sufficient condition to trigger the use of different sentence subjects, but also acknowledges that it is not the only factor shaping this preference. Our model embraces that the sentence subject could be used to indicate other things than the source of uncertainty, including simply and directly the subjectivity of the speaker.

6.2 Insight into how speakers choose internal and external probability phrases

Overall, our data suggest that the nature of the outcome and the context in which it is predicted drive the preference for internal and external probability phrases.

Preference for internal probability phrases to convey high likelihood. Participants preferred to describe outcomes that were more likely with internal probability phrases. This was for example the case when they described the output of the cast of a die (Experiment 1). Participants preferred to say "I am quite certain" than "It is quite certain" but would rather say "It is not certain" than "I am not certain". The preference for internal probability phrases is consistent with Fox and Malle's (1997) findings, who showed similarly that high numerical probabilities were more often introduced with the internal probability term *confidence* ("I am X% confident") and low numerical probabilities with the external probability term *probability*. The preference to convey high probabilities with the first person pronoun also fits well with the idea that more knowledgeable speakers prefer to use an internal source of uncertainty (Fox & Malle, 1997), and the fact that a lower degree of internal certainty is enough for participants to use a prediction (Løhre & Teigen, 2016).

The preference for internal high probability phrases and external low probability phrases observed in our experiment is limited to low negative probability phrases and high positive probability phrases. In our design, the lower probability phrases were also negative (i.e., *uncertain, not certain*)

whereas the high probability phrase was positive (i.e., *quite certain*). Hence, the preference for the external source could have been driven by the negative directionality of the lower probability phrases, and the preference for the internal source by the positive directionality of the high probability phrases. Negative probability phrases attract the recipients' attention towards the possibility that the target outcome will not occur (Juanchich, Teigen & Villejoubert, 2010; Sher & McKenzie, 2006). Using a first person pronoun negative directionality phrase may amount to acknowledging less and less certainty which participants may have wanted to avoid. In contrast, using an external negative low probability phrase may simply indicate that new evidence shows that the event is less likely than before. Future research should disentangle the role of the directionality of probability phrases in the preference for internal and external probability phrases, for example by offering a choice between a crossing of directionality and markers of the source (external low negative, external low positive vs. internal low negative, external low positive). A corpus study of people's preferences could also offer a more ecologically valid picture of people's preference.

Known and knowable outcomes are more often described with internal probability phrases. Our findings do not support that the time location of an outcome (i.e., in the past or the future) is on its own a predictor of the source of uncertainty that people choose to convey. For example, when assessing their uncertainty about the dangerousness of drugs, participants did not use a higher proportion of internal probability phrases for drugs of the past than for drugs of the future (Experiment 1). This hypothesis was derived from the common assumption that past outcomes rely more on lack of knowledge – hence an internal uncertainty – than future outcomes, which rely on both lack of knowledge and world stochastic processes – hence a mixture of internal and external uncertainty (Brun & Teigen, 1990). However, the relationship between temporality and the source of uncertainty might not be as straightforward. We proposed that the knowability of an outcome – the extent to which knowledge can reduce uncertainty – is a better predictor of the source of uncertainty experienced than the temporal location of the outcome. Results of Experiment 2 were consistent with this hypothesis: participants consistently preferred external probability phrases for past or present outcomes that are unknowable (e.g., life on Mars) and preferred internal probability phrases for past known and future predictable outcomes (e.g., the size of the Eiffel Tower and sea rise in 2100). We could infer from these findings that when making simple predictions, people have a preference for internal probability phrases because there are more facts that are known (e.g., the size of the Eiffel Tower) and future outcomes that are predictable and will be known, over outcomes that are unknowable.

Preference for markers of the source of uncertainty in conversations. Many predictions are not done in a conversational vacuum. Hence, we also investigated the role of previously voiced opinions on participants' preferences for internal and external probability phrases. Our findings showed that participants mirrored the source conveyed by their conversational partners, whether they agreed or disagreed with them (Experiment 1). This finding opens a new line of investigation, whereby the source of uncertainty of one person can affect the source of uncertainty expressed by another, simply by mirroring the choice of words and perhaps also by influencing the recipient's perceived source of uncertainty. Further research could focus on the effect of internal and external probability phrases on recipients' perceived source of uncertainty. This mirroring in conversation appears in line with the idea of coordination in dialogue and conversational alignment (Garrod & Anderson, 1987; Garrod & Pickering, 2004), characterized, for example, by lexical repetition (Garrod & Anderson, 1987; Garrod & Pickering, 2004). In our experiment, participants aligned their speech to their dialogue partner by making the same lexical choice and reusing the same pronoun subject.

By identifying factors that determine the preference for linguistic markers of the source of uncertainty in language, we inform factors that determine the type of uncertainty that people experience. Based on the findings presented here, we can suggest that people experience more internal uncertainty when experiencing higher levels of certainty, and knowability of the outcome, whether they gain more certainty by learning or over time. We have also shown that more incidental contextual factors drive the preference for markers of the source of uncertainty, such as the marker of the source used by a dialogue partner. In this case, the marker of the source may have a difference function: to increase the social coordination between dialogue partners.

Building on the finding that, out of a dialogue, the pronoun subjects of probability phrases are used as markers of the source of uncertainty of the speaker, which is itself derived from specific contexts, one could expect that hearers of those markers would make specific inferences about the speaker and the context. We have tested this hypothesis in two experiments.

6.3 Insight into what recipients infer from linguistic markers of the source of uncertainty

Inferences about the speaker. Speakers uttering external probability phrases were hypothesized to be perceived as more knowledgeable (Løhre & Teigen, 2016), but this was not found consistently (Løhre & Teigen; Experiment 1 vs. Experiment 3 and 4). The present paper's findings (Experiments 3 and 4) shed some light on the reasons why results

were inconsistent. A probability phrase with a third person neuter pronoun subject was not a sufficient condition for the speaker to appear as more knowledgeable. However, the pronoun subject did determine the perceived knowledge of the speaker, in interaction with the probability conveyed in the prediction and the expertise of the speaker. For example, hearers inferred that novices uttering external probability phrases were more knowledgeable than novices uttering internal probability phrases, whereas they inferred the opposite from expert speakers, who were considered as more knowledgeable when they gave internal phrases. Our results did not support that the use of internal or external probability phrases was a cue of the speakers' wishes (Experiment 3 and 4). This appears in contrast with Løhre and Teigen's findings, showing that, in the context of football predictions, internal probability phrases led recipients to believe that the speaker supported the team more than external probability phrases did (Experiment 4). The designs of the studies differ in a key point: we kept the probability conveyed by the speaker as constant (e.g., *quite certain*) and varied only the pronoun subject of the sentence (e.g., *I am quite certain* vs. *It is quite certain*). In contrast, Løhre and Teigen asked participants to complete an internal or external probability phrase with the numerical probability that would be most appropriate before they assessed the attitude of the speaker. The probability associated with internal probability phrases was higher (e.g., *I am 57% certain . . .*) than in the external condition (e.g., *It is 45% certain*), hence the probability phrases differed by more than the pronouns they featured. Speakers uttering an internal probability phrase may have been perceived as more supportive of the target team because they also conveyed a higher probability that the team would win.

Inferences about the prediction. In line with previous findings, our data showed that recipients judged external probability phrases as more informative than internal probability phrases. This replicates previous findings of the effect of the markers when associated with numerical probability phrases (Løhre & Teigen, 2016). In addition, consistent with Løhre and Teigen, we found that recipients did not think that internal probability phrases were more likely to be based on intuition than external probability phrases.

Inferences, implications for decision-making. As noted by Løhre and Teigen (2016), the internal-external probability distinction does not have a place in normative decision-making models but should definitely feature in descriptive models of decision-making, given that the source of uncertainty reflects a psychological reality that affects people's judgments and decisions. The source of uncertainty conveyed via the pronoun subject of the probability phrase did not have a main effect on the decision, but it interacted with the probability conveyed by the speaker and with his expertise to affect willingness to bet. Participants were more willing to use a low external probability phrase than a low internal probability phrase in betting but would rather use a high internal probability phrase than a high external probability phrase (Experiments 3 and 4). Further, participants were somewhat more willing to bet based on an internal probability phrase voiced by an expert, but keener to bet based on an external probability phrase voiced by a novice (Experiment 4).

We offer here insights into the properties of probability phrases, the determinants of their selection and their effects on the judgments and decisions of recipients. This could inform risk communication in different key societal domains, where risk communication is seen as a major challenge, such as in finance (Doupnik & Richter, 2003, 2004; Laswad & Mak, 1999), climate change (Budescu, Broomell & Por, 2009; Budescu, Por, Broomell & Smithson, 2014; Budescu, Por & Broomell, 2012; Patt & Schrag, 2003; Patt & Suraje, 2005; Sterman, 2011), medicine (Berry & Hochhauser, 2006; Berry, Knapp & Raynor, 2002; Berry, Raynor & Knapp, 2003), sentencing decisions (Dhami, 2008) or military intelligence (Dhami, Mandel, Mellers & Tetlock, 2015; Hastie, 1993). The difficulty of communicating uncertainty has led some regulatory bodies (e.g., the IPCC for climate change) to recommend the use of a reduced list of probability phrases. However, these lists do not feature the pronoun subject to be used and, hence, still leave room for variability. The features of probability phrases can be seen as a challenge but could also be seen as an asset that could be harnessed to develop more effective risk communication guidelines. For example, experts should use more internal probability phrases to appear more convincing whereas novices may be more effective by using external probability phrases.

6.4 Conclusion

In four experiments on uncertainty communication, we focused on the interpretation of whole probability phrases rather than isolated probability words (e.g., *I am certain* instead of *certain*) in which we manipulated the phrase subject (I am uncertain vs. it is uncertain). The present research brings some innovative findings about the factors that drive the preference for internal and external probability phrases. Results showed that participants exhibited consistent preference patterns, depending on their subjective probability, the degree to which knowledge could reduce uncertainty and, in dialogue, based on the source of uncertainty conveyed by a dialogue partner. The present paper demonstrates that pronoun subjects are (among other usages) used as linguistic markers of the source of uncertainty of the speaker, and that they affect recipients' judgments and decision-making.

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Appendix: Questionnaire used in Study 2

Below you will find a set of pairwise statements that express different degrees of certainty or uncertainty. Your task is to compare the two sentences in each pair and place a cross next to the sentence that appears more natural and sounds like an actual occurring statement. Even if they both seem natural, try to select the one that most likely is a genuine quotation.

1 [known_HighP]

(a) It is almost certain that UN was founded after the war

(b) I am almost certain that UN was founded after the war

2 [Predictable_HighP]

(a) It is quite certain that Spain will get to the 2012 European Football Championship

(b) I am quite certain that Spain will get to the 2012 European Football Championship

3 [Known_LowP]

(a) It is uncertain whether Sweden won the last match against Denmark

(b) I am uncertain about whether Sweden won the last match against Denmark

4 [Predictable_LowP]

(a) It is uncertain whether Sweden will win the next match against Denmark

(b) I am uncertain whether Sweden will win the next match against Denmark

5 [Unknowable_HighP]
(a) It is quite certain that there is life on other planets
(b) I am quite certain that there is life on other planets

6 [Unknowable_LowP]
(a) It is uncertain whether Robin Hood has actually lived
(b) I am uncertain about whether Robin Hood has actually lived

7 [Known_Low]
(a) It is uncertain whether Lithuania is south of Latvia
(b) I am uncertain about whether Lithuania is south of Latvia

8 [Known_High]
(a) It is certain that Toulouse is in France
(b) I am certain that Toulouse is in France

9 [Predictable_Low]
(a) It is not certain what I will do tomorrow
(b) I am not certain what I will do tomorrow

10[Predictable_Low]
(a) It is not certain that Hans will accept the offer
(b) I am not certain that Hans will accept the offer

Part II

Which of these two sentences are more convincing?
(a) It is certain I will arrive in time
(b) I am certain I will arrive in time

Which of these speakers will finish first?
A says: "It is not certain I will be finished on Monday"
B says: "I am not certain I will be finished on Monday"