Exhaustiveness in embedded questions. An experimental comparison of four predicates of embedding.

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We present an experiment investigating the exhaustiveness of embedded questions in German under four different verbs of embedding: *wissen* (*know*), *korrekt vorhersagen* (*correctly predict*), *sich einig sein* (*agree*), and *überrascht sein* (*surprise*).

Background. Embedded questions under **know** were originally thought to have a SE-reading only (Groenendijk & Stokhof 1984). (1) is hence true iff Ali knows of all the dancers that they danced, and of all the people that didn't dance that they didn't, i.e. he knows the full list of dancers and that this list is complete (Heim 1994).

(1)   Ali knows who danced.

Work that is more recent (e.g. Spector 2006, Klinedinst & Rothschild 2011) also discusses the availability of a weaker, intermediate exhaustive reading, according to which Ali knows the full list of dancers and holds no false beliefs regarding any non-dancers. Cremers & Chemla (2016) and Cremers et al. (2017) present experimental evidence for English and French that embedded questions under *know* not only allow for the IE reading, but that this reading is in fact almost equally acceptable as the SE reading. Such high acceptance is quite surprising, however. It is intuitively clear that if one says (1) and Ali knows the domain, he must also know who does not dance. It appears harder to accept statement (1) if Peter is unsure whether some people in the domain danced even if they, in fact, did not dance. For a semantic theory of questions, it is essential to know whether the two readings are equally available (see proposals by Uegaki 2015 and Zimmermann et al. 2019). Moreover, it is crucial for theory building to take into account different predicates of embedding (Heim 1994). In order to gain a comprehensive empirical overview, we experimentally investigated the availability of the exhaustive readings (strong, intermediate and weak [WE]) for four different predicates in German. Beside *wissen* (*know*), we tested *korrekt vorhersagen* (*correctly predict*), *sich einig sein* (*agree*) and *überrascht sein* (*to be surprised*). The speech act verb **predict** is the verb originally presented as a case in point for the availability of intermediate exhaustive readings of embedded questions (Spector 2006, Klinedinst & Rothschild 2011). IE readings of *predict* have been experimentally attested for English by Cremers & Chemla (2016). In the case of **agree** the truth of the propositions the attitude holders agree on is irrelevant. The alignment of their beliefs is what matters. There has been disagreement about the question to which extent the beliefs of the attitude holders have to be aligned (e.g. Spector & Égré 2007, Beck & Rullmann 1999, Lahiri 2002). An experiment by Chemla & George (2016) found that alignments of beliefs corresponding to SE and IE readings are acceptable. In the case of the non-distributive verb **surprise**, the SE reading constitutes the weakest reading, which is generally claimed not to exist (e.g. Heim 1994, Uegaki 2015). However, in an experiment by Cremers & Chemla (2017) it was attested. With regard to *surprise* we tested the availability of distributive and non-distributive WE readings as well as the availability of the SE reading,

Method. Participants did not judge the truth/falsity of a statement in vacuo, but in the context of a 'role play', in which their judgement is a basis for a subsequent decision with financial consequences for the participant, as the compensation for participating in the experiment was performance based. The experiment was in German and was conducted in a lab. Participants had to judge whether previously placed bets as in (2) have been winning or not. Participants were either assigned the role of a person having to decide whether to submit a bet (which cost a fee) (role1) or the role of a person working in a betting office having to decide whether to pay a reward to people that submitted bets (role 2). As there is evidence for the effort increasing potential of money in experiments (e.g. Camerer & Hogarth 1999), participants received actual coins as starter cash, which they had to employ in the experiment. We included the different roles to control for an answering bias for cases where the decision is not straightforward. A participant in role 1 is biased to judge in favor of the betting person, as s/he profits from won bets, whereas role 2 is biased to judge strictly as s/he profits from lost bets. For each verb, the design was a 3 (knowledge state: SE, IE/WE^{hom}, WE$^{(dis)}$ x 2 (negation: +/-) x 2 (role: 1 submit, 2 pay

reward) factorial design. We included negation to test whether the participants' judgments are consistent. Each participant judged 20 test items and 30 fillers.

(2)   Lina bets: Tim knows who of the participants petted a snake on the show.

       Tim's answer: Alessa, Freddy and Mara petted a snake on the show, but it is unclear to me whether Carlo and Sophie petted a snake on the show.

       What happened: Alessa, Freddy and Mara petted a snake on the show. Carlo and Sophie did not pet a snake on the show.

Results. We analyzed data from 23 participants. The role they were assigned to did not make a difference for their behavior. The participants judged consistently. The ratings for the four conditions are shown in Figure 1.
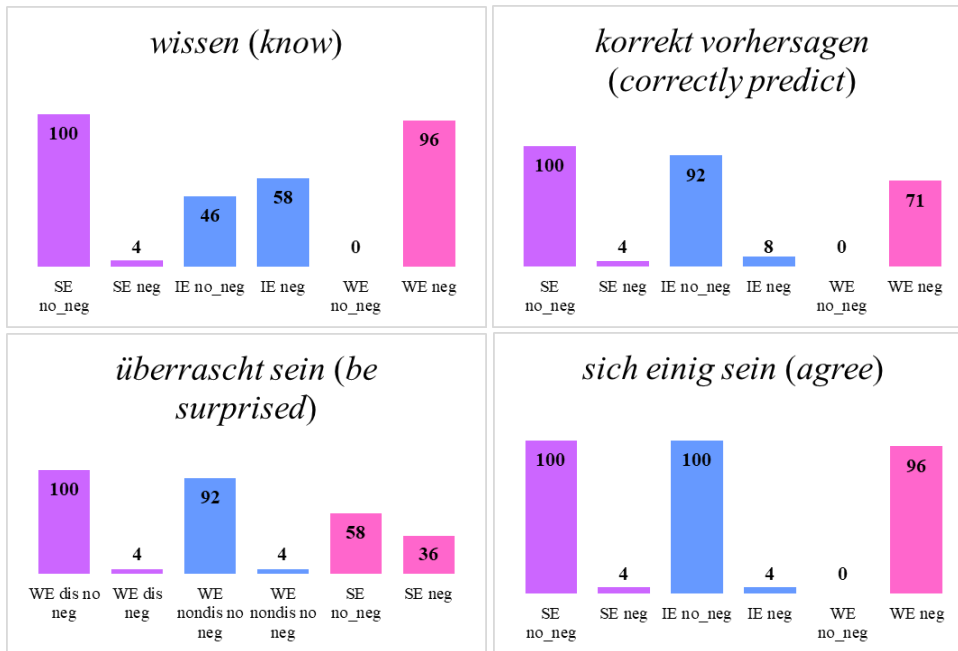

Figure 1. Acceptance per condition in percent.

Discussion. With regard to the verbs *correctly predict* and *agree*, we replicated the findings of earlier research. These verbs clearly allow for IE readings beside SE readings. Concerning *know*, our results confirm that the IE reading is available but suggest, in contrast to previous experimental results, that it is considerably less preferred than the SE reading, which still appears to constitute the default interpretation of questions embedded under *know*. We take these results to suggest that strong exhaustive readings constitute pragmatically enriched readings in line with Uegaki (2015) or Zimmermann et al. (2019). That the pragmatically enriched interpretation is the optimal interpretation is a parallel to scalar implicatures. Strikingly, questions embedded under *surprise* proved to be very liberal in their truth conditions as not only non-distributive readings but also SE readings were attested. Following Ginzburg & Sag (2000) and Abenina-Adar (2019), we interpret this to indicate that *surprise* selects for facts or situations instead of questions.

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