

Focus-sensitivity and homogeneity in attitude predicates*

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1. Introduction

Questions embedded under certain attitude predicates, such as *know* and *forget*, give rise to a truth-value gap that is analogous to the one arising with definite plurals, commonly known as *homogeneity* (first observed by Fodor 1970). Consider (1a) and its negation (1b): neither are made true by Mary reading only some of the books. The definite plurals in (1) cause this truth-value gap: the positive case is true iff Mary read all of the books, while the negated counterpart is true iff Mary read none—any other scenario verifies neither.

- (1) a. Mary read the books is **true iff** Mary read **all** the books.
- b. Mary didn't read the books is **true iff** Mary read **none** of the books.
- c. **Neither is true** iff Mary read only some of the books.

The same kind of truth-value gap can be observed in the case of questions embedded under *know*: if for only some of the books that Mary read, Jane knows that she read them, neither (2a) nor its negation (2b) are true.

- (2) a. Jane knows which books Mary read.
- b. Jane doesn't know which books Mary read.

On the basis of such data, Križ (2015b) argues that homogeneity with embedded questions follows directly from standard assumptions once an appropriate trivalent logic for homogeneity with definite plurals is adopted. In particular, Križ shows that any attitude predicate that universally quantifies over some set of worlds is predicted to give rise to homogeneity when it embeds questions or propositions with definite plurals.

In this paper we present novel data that shows that in some cases, whether the embedded constituent is a question or a declarative matters for the purposes of homogeneity. This is

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the case for certain attitude predicates that can embed both, like *surprise* and *scare*, which only exhibit homogeneity when they embed a declarative clause. The main goal of the paper is to explain what makes this class of attitude predicates different from the cases that Križ discusses.

Taking *surprise* as an example, we see that the question embedding case in (3) does not have the truth value gap we just observed above in the case of *know*. For example, (3a) can be uttered in a scenario like (4), where only some of the books that Mary read surprised Jane.

- (3) a. It surprised Jane which books Mary read.
(true iff for some of the books, Jane was surprised Mary read them)
- b. It didn't surprise Jane which books Mary read.
(true iff for none of the books, Jane was surprised Mary read them)
- (4) Books 1 and 2 are blue, while book 3 is red. Jane expected Mary to read books 1 and 3 but not 2. Instead, he read the blue books (1 and 2) and not 3.

However, we observe the now familiar truth-value gap when *surprise* embeds a declarative with a definite plural: neither (5a) nor (5b) can be truthfully uttered in the scenario in (4), where only some of the books were surprising to Jane.

- (5) a. It surprised Jane that Mary read the blue books.
(true iff for all of the blue books, Jane was surprised Mary read them.)
- b. It didn't surprise Jane that Mary read the blue books.
(true iff for none of the blue books, Jane was surprised Mary read them.)

In other words, the truth-value gap arises for these two sentences if for only some of the blue books, Jane was surprised that Mary read them. We argue that this class of predicates consists of focus-sensitive attitude predicates that embed questions, and that this peculiar distribution of homogeneous truth-conditions is precisely due to their focus-sensitive meaning and Križ's trivalent semantics for plurals.

2. Križ (2015): Homogeneity under *know*

In order to account for the truth-value gap with basic sentences with definite plurals such as (1), Križ (2015a) proposes that sentences in which distributive predicates apply to pluralities denote trivalent propositions:

- (6) A distributive predicate P is true of plurality x iff it is true of all parts of x , false iff it is false of all parts of x , and otherwise undefined.

Križ further observes that homogeneity projects seems to project following a Strong Kleene logic from the scope of quantifiers, giving rise to the projection pattern in (7) when a trivalent proposition is embedded under a universal quantifier.

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- (7) Given a predicate P , where $P(\alpha)$ is potentially trivalent for different values of α
- a. $(\forall\alpha P(\alpha)) = 1$ iff $\forall\alpha[P(\alpha) = 1]$
 - b. $(\forall\alpha P(\alpha)) = 0$ iff $\exists\alpha[P(\alpha) = 0]$
 - c. $(\forall\alpha P(\alpha)) = \#$ iff $(\exists\alpha[P(\alpha) = \#] \wedge \neg\exists\alpha[P(\alpha) = 0])$

Now, assuming a standard analysis of *know*, as a universal quantifier over over doxastic alternatives, we can straightforwardly derive the desired homogeneity gap when *know* embeds a proposition that contains a definite plural (i.e., a trivalent proposition). Following the projection pattern with universal quantifiers outlined in (7), Križ (2015b) predicts the homogeneity gap in (9) for proposition-embedding *know*.

- (8) $\llbracket \text{know} \rrbracket^{w_0} = \lambda p : p(w_0) = 1. \lambda x. \forall w' \in \text{Dox}(w_0, x) : p(x) = 1$
- (9) $\llbracket \text{Mary knows that Sally read the blue books} \rrbracket^w$
- a. 1 iff $\forall w' \in \text{Dox}(w, m)$: Sally read **all** of the blue books in w' .
 - b. 0 iff $\exists w' \in \text{Dox}(w, m)$: Sally read **none** of the blue books in w' .
 - c. # otherwise.

Assuming that $\llbracket \text{Mary knows } Q \rrbracket$ is equivalent to $\llbracket \text{Mary knows } p \rrbracket$, where p is the strongest true member of the Hamblin set of Q , the truth-conditions in (10) are predicted for the case of question-embedding *know*. For example, if Sally read books a , b , and c , in w , then the proposition $\llbracket \text{Sally read } a \oplus b \oplus c \rrbracket$ is the strongest member of the Hamblin set of Q in (10c). Since this proposition is trivalent, we predict the truth-value gap in (10c), corresponding to situations where Mary only knows some of the books that Sally read.

- (10) $\llbracket \text{Mary knows which books Sally read} \rrbracket^w$
- a. 1 iff $\forall w' \in \text{Dox}(w, m)$: Sally read in w' all of the books she read in w .
 - b. 0 iff $\exists w' \in \text{Dox}(w, m)$: Sally read in w' none of the books she read in w .
 - c. # otherwise.

Križ's account of homogeneity effects with *know* can be extended to any question-embedding attitude predicate whose meaning involves quantification over a domain of possible worlds. For example, consider the predicate *remember* p , which presupposes that the attitude holder had knowledge of p at some earlier time and asserts that the attitude holder believes p . Since $\llbracket \text{remember} \rrbracket$ universally quantifies over the set of belief worlds, we therefore expect to see the same projection pattern as *know*, where a homogeneity gap can be detected. This prediction is borne out, as shown in (11) for the question-embedding case.

- (11) Scenario: Mary used to know that John read the syntax books, but now she only remembers that he read half of them.
- a. #Mary remembers which books John read.
 - b. #Mary doesn't remember which books John read.

3. A focus-sensitive semantics for *surprise*

Sentences with predicates like *surprise* (unlike *know* and *forget*) are truth-conditionally affected by focus placement in their scope. Villalta (2008) and Romero (2015) take contrasts like (12) as evidence for treating the meaning of *surprise* as “focus sensitive”, since Focus placement is what distinguishes (12a) and (12b), and the given context verifies one but not the other.¹ In (12a), the relevant set of propositions are those denoted by sentences of the form *John taught syntax on x day*, and Lisa’s surprise is therefore at the fact that John taught syntax on Monday rather than on a different day.

- (12) CONTEXT: Lisa knew that syntax was going to be taught. She expected John to teach syntax. But she also expected syntax to be taught on Mondays.
- a. It surprised Lisa that John taught syntax on TUESdays. (true)
 - b. It surprised Lisa that JOHN taught syntax on Tuesdays. (not true)

Compare this with what happens when the embedding predicate is not focus-sensitive, like *know* in (13): there is no scenario that assigns the two sentences below different truth values.

- (13) a. Lisa knows that JOHN taught syntax on Tuesdays.
 b. Lisa knows that John taught syntax on TUESdays.

We implement a simplified version of the focus-sensitive meaning for *surprise* in Romero (2015), which builds on Heim (1992). Our lexical entry is given in (14), where $\text{Exp}_{x,w}(p)$ denotes the degree in w to which x expects p to be true and C is the comparison class determined by Focus². θ gives the threshold of expectedness for the comparison class C . $\llbracket p \text{ surprises}_C x \rrbracket^w$ is therefore true iff the degree to which x expected p in w is less than the degree to which x expected the propositions in C in w . If the complement \bar{p} of *surprise* bears narrow focus (e.g., *that SALLY taught syntax on Tuesdays*), its unexpectedness is not compared to the one of its negation but to every relevant proposition in the focus value of p (Rooth 1985).

$$(14) \quad \llbracket p \text{ surprises}_C x \rrbracket = \lambda w : p \in C. \text{Exp}_{x,w}(p) < \theta(\{\text{Exp}_{x,w}(q) \mid q \in C\})$$

Note that there is an additional focus-sensitive requirement at the presuppositional level. For example, in a context such as (15), where Mary had no expectation that Sally would buy a Ferrari, narrow focus on *red* causes the infelicity of (15a). Intuitively, this is because a presupposition is triggered that Mary believed that Sally would buy some Ferrari. This becomes clear when contrasted with the minimally different realization in (15b), which

¹Here and throughout the paper, capitalization of a word or a syllable indicates the prosodic correlate of Focus marking on some constituent.

²Throughout the rest of the paper, we simplify things by ignoring the factive presupposition of *surprise* and the requirement that someone has to believe p in order to be surprised at p . These components do not interact in any meaningful way with the homogeneity effects that we set out to explain.

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does not bear a similar presupposition— (15b) can be followed by *she thought it would be a Bentley*, unlike (15a). Note that the focus-sensitive semantics in (14) by itself predicts that (15a) should be acceptable in this scenario: Sally buying a red ferrari is less expected than Sally buying a ferrari of a different color (since Mary expected Sally to buy a blue car).

- (15) Scenario: Mary knew that Sally was going to buy a car and she expected it to be a blue car. She also expected Sally to buy an affordable car, so she was very surprised when she found out that Sally bought a red Ferrari.
- a. # Mary was surprised that Sally bought a RED Ferrari.
 - b. Mary was surprised that Sally bought a red Ferrari.

The contrast in (15) is directly accounted for by assuming that *surprise p* presupposes that the belief state of the attitude holder prior to finding out that *p* entails the disjunction of all salient propositional alternatives:

- (16) **Inclusion presupposition:** $\llbracket p \text{ surprises}_C x \rrbracket^w = \#$ if $\text{Dox}^<(x, w) \not\subseteq \bigcup C$
where $\text{Dox}^<(x, w)$ is *x*'s doxastic state in *w* prior to finding out that *p*.

With the natural assumption that the comparison class consists of the focus alternatives of the prejacent, we correctly predict that (15a) presupposes that before being surprised, Mary already believed that Sally was going to buy some Ferrari. Mary's surprise is therefore due to Sally buying a red Ferrari, rather than a Ferrari of some other color. In the example in (15b), on the other hand, we take the set of alternatives to simply consist of the prejacent *p* and its negated counterpart $\neg p$. The presupposition is therefore vacuously satisfied in this case (all belief states should entail the tautology). Note that (16) alone would explain why (12b) is not true in the given scenario: Lisa did not believe someone was teaching syntax on Tuesdays. However, we are going to see that reference to focus alternatives in the assertive component, as Villalta's and Romero's proposals have it, is crucial to account for the truth-conditions in the question-embedding case.

4. Deriving the asymmetry with respect to homogeneity

In this section, we explore the predictions of Križ's account of homogeneity for *surprise*, given the assumptions made in section 3. The argument will be this: no homogeneity effect is predicted to arise with question-embedding surprise, given that the alternatives introduced are possible answers to the question, but when the embedded clause is a declarative with a definite plural, the homogeneity gap follows from the inclusion presupposition.

Given our lexical entry of *surprise*, we must ask how the degree of unexpectedness for a trivalent proposition is determined. Given a trivalent proposition *p*, we propose that $\text{Exp}_{x,w}(p)$ gives the degree to which *x* in *w* expects *p* to be true. This predicts that two propositions which are true under the same conditions should have the same degree of expectedness, regardless of whether they are false or undefined under the same conditions.

Starting with the case of proposition-embedding with no narrow focus, the assumption is that the comparison class C includes only the prejacent and its negation. This can be motivated by the fact that the sentence in (17), both with and without verum focus, seems to convey that Mary was surprised that Jane read the books instead of not reading them. In particular, unlike the question-embedding case and the case with narrow focus, there are no propositions that are relevant to evaluating Mary's degree of *surprise* other than the one denoted by the embedded clause and its negation.

(17) Mary was surprised that [Jane (DID) read the books] _{p} .

In this case, our inclusion presupposition is only satisfied if Mary believes $p \vee \neg p$. If p involves distributive predication over a plurality, the presupposition is only met if prior to finding out that p , the attitude holder believes that the predicate holds of either all or no parts of the plurality, as shown in (18). This delivers the homogeneity effect observed with proposition-embedding *surprise*.

(18) Given a sentence of the form x surprised $P(y)$, where y is a plurality and P is a distributive 1-place predicate:

a. $C = \{\lambda w.P_w(y), \lambda w.\neg P_w(y)\} = \{\forall z \leq y : P(z), \forall z \leq y : \neg P(z)\}$

b. **Inclusion presupposition** (when evaluating at w):

$$\text{Dox}^<(x, w) \subseteq \{w' \mid \forall y \leq x : P_{w'}(y) \vee \forall y \leq x : \neg P_{w'}(y)\}$$

For example, in the case of *It surprised Jane that Mary read the blue books*, we predict the truth-conditions in (19), assuming that a and b are the blue books. The proposition is defined iff Jane's prior belief worlds included only worlds where Mary read all of the blue books and worlds where she read none of them. If Jane was surprised by some but not all of the books that Mary read, then Jane necessarily believed that Mary could read some of the books without reading all of them. There would therefore have to be world in Mary's prior belief worlds in which Mary read some but not all of the books, thus violating the inclusion presupposition. We therefore predict the homogeneity gap in this case.

(19) $\llbracket \text{It surprised Jane that Mary read the blue books} \rrbracket =$
 $\lambda w : \text{Dox}^<(j, w) \subseteq \cup \{\lambda w'. \llbracket \text{read} \rrbracket^{w'}(a \oplus b)(m), \lambda w'. \neg \llbracket \text{read} \rrbracket^{w'}(a \oplus b)(m)\}.$
 $\text{Exp}_{j,w}(\lambda w. \llbracket \text{read} \rrbracket^w(m)(a \oplus b)) < \text{Exp}_{j,w}(\lambda w. \neg \llbracket \text{read} \rrbracket^w(m)(a \oplus b))$

As for the case where *surprise* embeds a question, we make the standard assumption that the meaning of a question is the set Q of its possible answers (Hamblin 1976) and that at least in certain conditions there is a way to select a complete true answer from that set, $\text{ANS}(Q)$ (Dayal 2012). Thus, being surprised at a question is being surprised at the strongest true answer to the question. Furthermore, we assume that the focus semantic value of a question is the set of possible answers in the Hamblin set for the question. With a domain consisting of three books a , b and c , the denotation for *which books Mary read* (which is

the comparison class that is relevant to the interpretation of the *surprise* report) is shown in (20).

$$(20) \quad \llbracket \text{which books Mary read} \rrbracket = \\ C = \{\lambda w. \text{read}_w(m, x) \mid x \in \{a, b, c, a \oplus b, a \oplus c, b \oplus c, a \oplus b \oplus c\}\}$$

The truth-conditions in (21) are therefore predicted for the case of question-embedding surprise in (3). We predict no truth-value gap due to homogeneity in this case: if Mary reads *a* and *b*, (21) is true iff the degree of expectedness of Mary reading both *a* and *b* is less than the threshold degree of expectedness of Mary reading any other set of books, while the negated counterpart is true iff the former degree is not less than the threshold. Furthermore, the inclusion presupposition is met as long as Jane believed that Mary would read some book or books.

$$(21) \quad \llbracket \text{It surprised Jane which books Mary read} \rrbracket = \\ \lambda w : \text{Dox}^<(j, w) \subseteq \bigcup \llbracket \text{which books M. read} \rrbracket . \\ \text{Exp}_{j,w}(q) < \theta(\{\text{Exp}_{j,w}(r) \mid r \in \llbracket \text{which books M. read} \rrbracket\}) \\ (\text{where } q \text{ is the strongest true proposition in } \llbracket \text{which books M. read} \rrbracket).$$

Note here that if the degree of expectedness of *q* were compared only to $\neg q$, we would incorrectly predict (21) to be false in a scenario where Mary knew that Jane would read book *b* but expected her to also read book *c* rather than book *a*. Here, $\neg q$ would correspond to *Mary neither read book a nor book b*, which has a degree of expectation of 0 in this scenario, making (21) necessarily false.

If sentences with presuppositions also denote trivalent propositions (e.g., Van Fraassen 1966, Peters 1979), our account also makes specific predictions about how presuppositions project from the scope of *surprise*. With proposition-embedding *surprise*, we see that we correctly predict that (22a) presupposes that Mary believed that John used to smoke, while (22b) has no such presupposition. If we assume that the alternatives for the prejacent in both cases are $\{p, \neg p\}$, we predict that the inclusion presupposition is only satisfied in (22a) if prior to finding out that John stopped smoking, Mary believed that John used to smoke. On the other hand, the inclusion presupposition is trivially satisfied with an embedded clause like (22b)'s.

- (22) a. It surprised Mary that John stopped smoking.
 b. It surprised Mary that John used to smoke and no longer does.
 c. It surprised Mary which students stopped smoking.
 d. It surprised Mary which students used to smoke and no longer do.

Looking at the question embedding case in (22c), we predict that the inclusion presupposition is met as long as Mary believed that someone stopped smoking. For (22d), we again predict that the inclusion presupposition is met if Mary believed that someone used to smoke and no longer does. We therefore predict the same truth-conditions for (22c) and (22d).

To test this prediction, consider scenario (23). We predict that both (22d) and (22c) are true here. While (22d) can be uttered in (23), it is not clear to us whether (22c) can express surprise about the students having smoked in the first place. Note that it has been argued that homogeneity and presuppositions do not project in the same way (Spector 2013, Križ 2015a) so it is possible that something more must be said in order to account for (22c).

- (23) **Scenario:** There are 3 students: *a*, *b*, and *c*. *a* and *b* used to smoke but have stopped smoking recently. *c* never smoked. Prior to finding out which students stopped smoking, Mary incorrectly expected that *c* has stopped smoking recently and that *a* and *b* never smoked.

5. Beyond *surprise* and *know*

It is well known that question-embedding *know* and *surprise* differ in the kind of exhaustive interpretation that the embedded answer receives. *Know Q* is usually argued to have a strongly exhaustive interpretation (Groenendijk and Stokhof 1984), while *surprise Q* has a so called weakly exhaustive interpretation (Heim 1994). For example, (24a) is true iff Mary knows both which stocks went up and which stocks didn't go up, while (24b) entails nothing about Mary's attitude towards the stocks that did not go up. For instance, (24b) is not true in a scenario where stocks s_1 and s_2 went up and s_3 went down but Mary expected all three stocks to go up (i.e., she was only surprised by s_3 going down).

- (24) a. Mary knows which stocks went up.
b. It surprised Mary which stocks went up.

Could this distinction be what drives the homogeneity contrast we observed in section 1? The answer is no—the exhaustivity distinction cross-cuts the pattern of interest here, as can be seen by the fact that there exist predicates like *forget*, which pattern with *know* with respect to homogeneity (25) and with *surprise* with respect to exhaustivity (26).

- (25) SCENARIO: Jane read *a*, *b*, and *c*. Mary only remembers that she read *a* and *b*.
a. Mary forgot which books Jane read. (not true)
b. Mary didn't forget which books Jane read. (not true)
- (26) SCENARIO: Mary used to know that stocks s_1 and s_2 went up but s_3 and s_4 went down. Now, she thinks that all four stocks went down.
a. Mary forgot which stocks went up. (true)
b. Mary forgot which stocks went down. (not true).

Finally, note that the pattern with *surprise* and homogeneity can be replicated with other emotive predicates that are presumably focus sensitive, including *happy*, *worried*, *scared*. We notice a contrast between *happy* and *surprise*: even though, as predicted, question-embedding *happy* has no homogeneity gap, its truth-conditions appear to be respectively

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stronger in the positive case and weaker in the negative case than what they are in the case of *surprise*. For example, in the case in where Mary was only happy about some of the books that Jane read (27), only the negated version is true.

- (27) Scenario: Mary wanted Jane to read books a and b but not book c. Instead, Jane read books b and c but not a.
- a. Mary was happy about which books Jane read (not true)
 - b. Mary wasn't happy about which books Jane read. (true)

On the other hand, if only some books were not in Mary's expectations, as we saw, it's true that she is surprised at which books Jane read (and false that she isn't). We take this distinction to simply be due to a difference in how the degree of expectedness and the degree of happiness about a proposition are calculated.

The exact same contrast manifests itself clearly with quantificational variability effects, which have been discussed extensively for predicates like *know* and *remember* (starting with Berman 1991 a.o.): In (28a), adding *for the most part* results in a stronger proposition than the basic case, while in (28b) it results in a weaker one (being *happy for the most part* does not entail being happy, being *surprised for the most part* entails being surprised).

- (28) a. For the most part, Mary was surprised by which books Jane read.
b. For the most part, Mary was happy about which books Jane read.

6. Outstanding issues and conclusion

We have provided an analysis that derives the unique behavior of focus-sensitive attitude predicates with respect to homogeneity from Križ's (2015a) trivalent semantics for plural predication. The analysis succeeds in accounting for two cases of embedding under surprise: question embedding and proposition embedding, where the focus alternatives are possible answers to the question, and the embedded proposition and its negation respectively. It remains to be seen how the present account generalizes to more complex cases where there is narrow focus on the prejacent and with multiple focus constructions. We make a few notes about this below.

Consider the case of narrow focus: (29) conveys that Jane found it surprising that Mary read any of the blue books. Recall that the *surprise-which* counterpart is true as long as some of the books are such that it surprised Jane that Mary read them.

- (29) Jane was surprised that Mary read the BLUE books.

The present analysis predicts this meaning of (29), as long as the comparison class includes only those propositions denoted by sentences of the form *Mary read x* where *x* and the blue books are disjoint. Then, for the inclusion presupposition to be met Jane had to believe that Mary would either read all of the blue books or some other set of books. In a context where

this presupposition is met, if Mary was surprised about Jane reading one of the blue books, then she was necessarily surprised about every blue book that Jane read.

Note that when there is narrow focus in the negated counterpart in (30), focus does not contribute to determining the comparison class for *surprise* but instead indicates that Jane was surprised about some other set of books that Mary read. Therefore, it seems that narrow focus cannot associate with *surprise* under negation but must instead be interpreted globally (whereby the focus alternatives are all *surprise*-reports). We leave it as an open question why there is this asymmetry between the positive and negative case with narrow focus.

(30) Jane wasn't surprised that Mary read the BLUE books.

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