On the QUD sensitivity of a Third reading[1]

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Abstract. We provide the first experimental evidence supporting the hypothesis that transparent readings are sensitive to the QUD (Question Under Discussion) (Schwager, 2009; Percus, 2020; Benbaji-Elhadad, 2023; Mayr and Schmitt, 2023, 2024), using third readings (Fodor, 1970) in attitude reports. In particular, we test Mayr and Schmitt's (2023; 2024) claim that, even among QUDs about the attitude holder's mental state, there is difference in the availability of transparent readings. Our results have consequences for replacement-based theories of transparent readings and more broadly illuminate properties of a discourse that give rise to and constrain a QUD about someone's mental state.

Keywords: third reading, transparent reading, *de re*, question under discussion.

1. Background

1.1. QUDs addressed by an attitude report: *Factual* and *attitudinal*

We experimentally investigate the hypothesis that availability of a transparent reading is sensitive to the Question Under Discussion (QUD) (Schwager, 2009; Percus, 2020; Benbaji-Elhadad, 2023; Mayr and Schmitt, 2023, 2024), using third readings (Fodor, 1970) in attitude reports. Following Roberts (2012) and Stalnaker (2002), we take the view that "the primary goal of discourse is communal inquiry – the attempt to discover and share with the other interlocutors "the way things are," i.e., to share information about our world" (Roberts, 2012: 6:4). In this framework, there are two major moves one can make in a discourse, raising a question and answering a question; the (immediate) question under discussion (QUD) is a question that has been raised and accepted as "the immediate topic of discussion" (Roberts, 2012: 6:5).

It has been recognized that in an attitude report, either the entire report or the embedded proposition alone can address a QUD (Urmson, 1952; Hooper, 1975; Simons, 2007; Beaver, 2010; Simons et al., 2017; AnderBois, 2016; Beaver et al., 2017). For convenience, we will refer to QUDs addressed by an entire report as *attitudinal* QUDs, and those addressed by the complement alone as *factual* QUDs, here only focusing on attitude reports with a single layer of embedding.[2] Examples of attitudinal and factual QUDs addressed by the same attitude report are given in (1a) and (1b), respectively.

(1) a. *Attitudinal* QUD: Who does Ana think Bob is dating?
Ana thinks that Bob is dating Cindy.
b. *Factual* QUD: Who is Bob dating?

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[2]When there are multiple layers of embedding, the simple distinction between *attitudinal* and *factual* QUDs gains an additional level of complexity. For example, the question in (1a) can be addressed by *(I don't know, but) David said that Ana thinks that Bob is dating Cindy* (Yael Sharvit, p.c.); in this case, the question concerns an attitude but is addressed by an embedded proposition.

(I don't know, but) Ana thinks that Bob is dating Cindy.

Attitudinal QUDs concern the mental state of the attitude holder, whereas factual QUDs concern facts in the evaluation world.[3]

1.2. Factual QUDs and transparent readings

Factual QUDs have been observed to facilitate *transparent* readings (i.e. evaluated with respect to the utterance context) where otherwise one only finds *opaque* readings (i.e. evaluated with respect to the subject's attitude). First, responding to Percus's (2020) claim that the main predicate in an attitude complement, such as *is Canadian* in (2), cannot receive a transparent reading, Kaufmann, in Schwager (2009), argues that such a reading is available in the right context.

(2) Mary thinks that my brother is Canadian. (Percus, 2000: 196(26a))

Kaufmann writes, "Assume I have an older step-brother who grew up in a different part of the world, so I don't know much about him. He is one of our students. We are just interested in who among our students is Canadian and who is not. Now, assume Mary knows that this person was born in Canada, but is not sure whether this is enough for citizenship. We are not interested in Mary's state of mind, we merely use it as further help to settle the issue we are actually after. In such a case, [(2)] appears to be true" (Schwager 2009:410-411). Notice that this context supports a factual QUD, 'Is my brother Canadian?'

Second, Percus (2020) points out that factual QUDs allow what appear to be a special case of a transparent reading in which not only a single expression but an entire complement clause expresses information that is not part of the attitude holder's mental representation (henceforth 'pseudo-*de re*' (Recanati 2012, Sharvit 2018; term attributed to Kaplan 1989).[4] Percus (2020:24) remarks, "Suppose that Mary is flying in today on Flight AF 62. We are all eagerly awaiting her arrival. We know however that the departure was delayed and so we are not sure when exactly she will be getting in. At a certain point I remember that our friend John works at the airport, so I call him to ask if Flight AF 62 has landed. He says that he believes that in fact it has. I could then turn to you and tell you the sentence in [(3)]."

(3) John thinks that Mary has arrived. (Percus, 2020: 24(45))

The point is that in the context provided, John is not acquainted with Mary. Hence, traditional approaches to transparent readings such as evaluating *Mary* at the evaluation world (von Fintel and Heim 2011; Percus 2000; Keshet 2008, 2010; Demirok 2019, 2020; henceforth 'transparent evaluation' theories) and postulating an acquaintance-based concept generator for *Mary* (Kaplan, 1968; Cresswell and von Stechow, 1982; Percus and Sauerland, 2003) cannot account for (3). Notice that in this case, too, the QUD is factual, as in 'Has Mary arrived?'

[3] In the previous literature, when attitude reports are used to address factual QUDs, the attitude verb has been called 'parenthetical' (Urmson, 1952) or 'evidential' (Simons, 2007). AnderBois (2016), demonstrating that attitude reports in Yucatec Maya morphologically mark the at-issueness of the entire report vs. the complement, makes a distinction in terms of whether the discourse is about 'the mental state' or 'the attitudinal object.' This is not to be confused with *attitudinal* QUDs in our terms. A QUD about the mental state is an attitudinal QUD, and a QUD about the attitudinal object is a factual QUD in our terms.

[4] See also Blumberg and Holguín (2018), Blumberg and Lederman (2021).

1.3. Attitudinal QUDs and transparent readings

Mayr and Schmitt (2023, 2024) argue that some attitudinal QUDs can also license transparent readings. The story in (4) supports only the transparent reading of *Ann* when the attitude holder is Joe. Mayr and Schmitt claim that, in that context, (4a) is acceptable, while (5a) is not. They argue that the implicit QUD responsible for these judgements are respectively (4b) and (5b).

(4) Scenario: Joe went to a party. Ann and Eve were among the guests. Joe recognizes Eve, but not Ann (and does not think Eve knows Ann). He saw them dancing with each other and thinks Eve and the person she danced with are lovers. *There was debate about Eve's relationship status.*

   a. ✓Joe thinks that Eve is involved with **Ann**.
   b. Hypothesized QUD: Does Joe think that Eve is single?

(5) Scenario: [...] *We are discussing who Joe thinks was at the party.*

   a. ×Joe thinks that **Ann** was at the party.
   b. Hypothesized QUD: Does Joe think that Ann was at the party?

For convenience, we will refer to QUDs like (4b) as attitudinal *existential* QUDs on the basis that they ask about the attitude holder's belief about existence of an entity with a certain property independent of the transparently interpreted expression. Take a schematic representation of an attitude report of the form *x thinks that y is P*, where y is the description to be interpreted transparently (6).

(6) λw. $\forall$w′$\in$DOX$_{x,w}$: P(y)(w′)

Then an attitudinal existential question can be formulated as in (7), which simply asks about the existence of an individual corresponding to y in (6) regardless of their identity.

(7) {λw. $\forall$w′$\in$DOX$_{x,w}$: $\exists$z[P(z)(w′)], λw. $\forall$w′$\in$DOX$_{x,w}$: $\neg\exists$z[P(z)(w′)]}

Although Mayr and Schmitt contrast the attitudinal existential question with 'Does Joe think that Ann was at the party?' (5b), it is hard to see this question arising as an implicit QUD in the context provided, where Joe himself doesn't identify Ann as *Ann*. Instead, we will contrast attitudinal existential QUDs with what we will call attitudinal *wh* QUDs (8), which asks about the identity of the individual corresponding to y in (6). In the context in (5), the attitudinal *wh* question would be 'Who does Joe think was at the party?'

(8) {λw. $\forall$w′$\in$DOX$_{x,w}$: P(z)(w′) | z is a human}

The potential QUD sensitivity has consequences for discussions of transparent readings on two levels. On the empirical level, if the QUD is a factor in whether a transparent reading is available for a given expression, it must be carefully controlled in assessing the (un)availability of transparent readings. On the theoretical level, the potential QUD sensitivity has direct consequences especially for a subset of 'replacement' theories that impose different QUD conditions for replacing a transparently interpreted expression (Percus 2020; Mayr and Schmitt 2023, 2024; Benbaji-Elhadad 2023; see Section 3.1).

Given its significance, Mayr and Schmitt's claim about (4a) and (5a) should be better supported. First, the two examples do not constitute a minimal pair in that the attitude reports themselves

are not string-identical. Second, it is hard to recover the hypothesized QUDs in the setting in (4). This is partly because there is no explicit characterization of discourse agents, which leaves the details open about the interlocutors' knowledge states. If the implicit author and the reader are the intended discourse agents, then both have complete knowledge of Joe's relevant beliefs; such a setup is similar to exam situations, where those producing and answering a question are both expected to know the answer to the question beforehand. Finally, QUD effects are hard to intuit, and there should be a better understanding of the properties of a discourse that give rise to transparent reading-compatible QUDs. To this end, an experiment that tightly controls both the context and the attitude report would appear to be a promising avenue, as experimental studies have provided valuable insights into other QUD-sensitive semantic phenomena.[5]

2. Experiment

We test Mayr and Schmitt's empirical claim that an attitudinal existential question licenses transparent readings, contrasting it with an attitudinal *wh* question. In particular, we compare a transparent reading of the descriptive content of an indefinite DP, that is, a 'third' reading (Fodor, 1970), with an opaque reading.[6] The reason we chose property-denoting expressions rather than proper names is that, for the latter, an interpretation of the results would depend on one's view of the semantics of proper names. In particular, under the assumption that they are rigid designators, their transparent interpretations require an acquaintance relation (Quine, 1956; Kaplan, 1968; Lewis, 1979), and simply evaluating them at the evaluation world would not suffice. Property denoting expressions enable an informative comparison of replacement-based and transparent evaluation theories. Moreover, third readings were chosen instead of the canonical *de re* readings in which the existential force of an indefinite scopes over the attitude verb; this is because third readings constitute a minimal pair with our baseline, canonical *de dicto* (opaque) readings, differing only in transparency and not quantifier scope.

2.1. Design

Our 2x2 experimental design crossed the QUD (attitudinal existential vs. attitudinal *wh*) with transparency (transparent vs. opaque). Both variables were between-subject, with participants randomly assigned to one of the four groups (Table 1). Each participant read a single story, contributing a single data point. This has the drawback that we cannot make any inference about trends in individual speakers' grammars, such as whether there are inter-speaker differences in how easily transparent readings are accessed (see Zhang and Davidson 2024).

Despite this drawback, there were important reasons for this decision. First, each story was quite long; this was necessary in order to motivate an attitudinal question and an attitude report. Second, our pilot studies showed that QUD effects are subtle. Given the subtlety of the effect and the potential ambiguity between transparent and opaque readings, it was crucial to minimize

[5]See Lewis et al. (2012) and Hacquard and Lidz (2019) on children's interpretations of attitude reports; Cremers et al. (2017) and Westera and Brasoveanu (2014) on ignorance inferences; Kursat and Degen (2020) and Ronai and Xiang (2021) on scalar inferences; Augurzky et al. (2023) on non-maximality; and Evcen et al. (2025) on conditional perfection.

[6]Mayr and Schmitt's theory (see Section 3.1) is generalized to various semantic types, and third readings are also discussed.

Table 1: Four between-subject groups by QUD and transparency.

	QUD	transparency
Group 1	existential	transparent
Group 2	existential	opaque
Group 3	*wh*	transparent
Group 4	*wh*	opaque

carry-over effects. We tested these in three stories (A, B, C), also given between participants.

2.1.1. Task and stimuli

Participants first read an entire story, accompanied by an image to facilitate imagining of the context. The story was presented sentence by sentence, with a button to proceed to the next sentence appearing after 230*[word length] milliseconds later. The Group 1 version (existential QUD * transparent; see Table 1) of Story A is presented in Fig. 1.[7]

Mia moved into a new apartment last week. Her floor is very quiet, so she was wondering if the apartment next door is vacant. It is in fact vacant, but Mia didn't know that for a fact. Yesterday, before she left to go furniture shopping for her new apartment, Mia saw a group of three men in the hallway. The men were each viewing the apartment next door, and they all happened to be programmers. However, Mia didn't know any of that. Now Mia thinks that one of the men she saw in the hallway yesterday lives in the apartment next door, although she isn't sure which man.

Figure 1: Participants' view of the story in the existential QUD*transparent condition.

Then the participants were told that Ann, who read only the beginning of the story, will ask Bob, who read the whole story, questions about the rest of the story. The screen showed what Ann and Bob each read (Fig. 2). With Fig. 2 still on the screen, the participants saw a dialogue between Ann and Bob (9), where Ann asks a question about the protagonist's attitude, and Bob utters the target attitude report in response. Crucially, Bob's response was string-identical across the four groups, ensuring that any difference in judgements could not be due to the form of the attitude report. The participants' task was to indicate whether they "Agree" or "Disagree" with Bob's report, given the content of the whole story.

(9) Ann. I read that Mia was wondering if the apartment next door is vacant. What does she think now?

Bob. She thinks that a programmer lives next door.

[7] A full list of stimuli is available at https://osf.io/3wtc4

Remember, Ann only read the beginning of the story, and Bob read the whole story, as shown below.

What Ann read	**What Bob read**
Mia moved into a new apartment last week. Her floor is very quiet, so she was wondering if the apartment next door is vacant. It is in fact vacant, but Mia didn't know that for a fact.	Mia moved into a new apartment last week. Her floor is very quiet, so she was wondering if the apartment next door is vacant. It is in fact vacant, but Mia didn't know that for a fact. Yesterday, before she left to go furniture shopping for her new apartment, Mia saw a group of three men in the hallway. The men were each viewing the apartment next door, and they all happened to be programmers. However, Mia didn't know any of that. Now Mia thinks that one of the men she saw in the hallway yesterday lives in the apartment next door, although she isn't sure which man.

Figure 2: Participants' view of the story in the existential QUD*transparent condition.

The intended existential QUD in (9) is provided in (10).

(10) Does Mia think that the apartment next door is vacant? ~ Does Mia think that there is someone who lives in the apartment next door?[8]
{λw. $\forall$w′$\in$DOX$_{Mia,w}$: $\exists$y[y lives next door in w′], λw. $\forall$w′$\in$DOX$_{x,w}$: $\neg\exists$y[y lives next door in w′]}

For comparison, the story, the target dialogue, and the intended QUD in the Group 3 version (the *wh* QUD * transparent) of Story A are provided in (11)-(13).

(11) Story: Mia moved into a new apartment last week. She knew that the apartment next door is occupied, but she didn't know anything about the person who lives there. She was hoping to learn more about her neighbor. In particular, Mia was wondering what her next-door neighbor does for work. Unbeknownst to Mia, her neighbor is actually a carpenter.

Yesterday, before she left to go furniture shopping for her new apartment, Mia saw a group of three men in the hallway. They were actually visiting Mia's neighbor, and they all happened to be programmers. However, Mia didn't know any of that. Now Mia thinks that one of the men she saw in the hallway yesterday lives in the apartment next door, although she isn't sure which man.

[8]The paraphrase here is only meant to indicate that answering one question answers the other, setting aside differences in biases when these questions are uttered (Buring and Gunlogson, 2000; Eckardt, 2008).

(12) Ann. I read that Mia was wondering what her next-door neighbor does for work. What does she think now?

Bob. She thinks that a programmer lives next door.

(13) *Wh* QUD: "What does Mia think her next-door neighbor does?"
$\{\lambda w.\ \forall w' \in DOX_{Mia,w}\colon \exists y[P(y)(w')=1\ \&\ y \text{ lives next door in } w'] \mid P \text{ is of type } \langle s,et\rangle\}$

While the four groups share the overall context of the story, there are multiple differences in the details of the story between them, as can be seen by comparing Group 1 (Fig. 1) and Group 3 (11) above. This is because a QUD is a property of a discourse, whose goal is to 'discover and share with the other interlocutors "the way things are" i.e., to share information about our world' (Roberts 2012:4). Hence, manipulating the QUD requires manipulating the state of the world as well as the knowledge state of each interlocutor. In the experiment, the former is manipulated by the content of the story, and the latter by the combination of the content of the story and which parts of the story Ann and Bob has access to. Moreover, since the target sentence is an attitude report, the state of the world includes the attitude holder Mia's mental state.[9] Elements of the stories that facilitate QUD manipulation are discussed in detail in Section 3.2.

2.1.2. Participants and inclusion criteria

We tested our 2x2 design across three distinct stories (Story A, B, C) to probe generalizability. For each story, 400 self-reported monolingual English speakers residing in the U.S. were recruited on Prolific, and received $ 5 for participation in the study. Participants were randomly assigned to one of the four groups created by crossing the QUD and transparency (Table 1).

There were three inclusion criteria. First, a self-report: the participant had to answer "Yes" to the question "Are you a native English speaker?" in a language background survey following the experimental trial. Our second and third criteria were performance-based. There was a practice item introducing the setup of the experiment, where the participants read a short story and two question-answer dialogues between Ann and Bob about the content of the story. The participants were told whether they should choose 'Agree' or 'Disagree' and the reason behind the answer. In the main experiment, in addition to the target dialogue, there were two other dialogues that served as filler and attention-check items; the order of the target and the two filler dialogues was randomized across participants. Both practice and filler items matched the target item in form; Ann made a two-sentence utterance of the form "I read that [...]. [Question]," and Bob uttered a single declarative sentence. However, none of them included an attitude report. Of the two practice and filler items, respectively, one clearly solicited an "Agree" response, and the other "Disagree." The participants had to answer all four (practice and filler) items correctly.

After the exclusion, Story A had 356 participants (Group 1: 86; Group 2: 88; Group 3: 82; Group 4: 100), Story B had 359 participants (G1: 104; G2: 89; G3: 82; G4: 84), and Story C had 345 participants (G1: 88; G2: 91; G3: 81; G4: 85).

[9]See Farkas 2003 for a model of a discourse that explicitly tracks mental states of individuals represented in the discourse.

2.2. Prediction

According to the introspective judgements provided by Mayr and Schmitt (2023, 2024), an attitude report that is only true under a transparent reading should be acceptable as an answer to an existential QUD but not to a *wh* QUD. That is, in the current experiment, Group 1 (existential QUD * transparent reading) should have a higher agreement rate than Group 3 (*wh* QUD * transparent reading). On the other hand, an attitude report that is only true under an opaque reading should be acceptable as an answer to both existential and *wh* QUDs. That is, Group 2 (existential QUD * opaque reading) and Group 4 (*wh* QUD * opaque reading) should both have a high agreement rate, with no significant difference between them.

Furthermore, there should be a significant interaction between QUD and transparency such that the positive effect of existential QUDs is greater for the transparent condition. The interaction is crucial in order to attribute any difference observed between the two QUDs to the availability of the intended reading under the respective QUDs. Given that the task is to rate an attitude report as a response to a question given the content of the story, there are other factors that could explain differences in acceptability judgements. Of particular concern is that participants may 'Disagree' with the target attitude report because they think of a different linguistic form that they perceive to be more congruent with the question. Examples of alternative responses for existential and *wh* questions are provided in (14) and (15), respectively.[10]

(14) Ann: I read that Mia was wondering if the apartment next door is vacant. What does she think now?
Bob: She thinks that someone lives there.

(15) Ann: I read that Mia was wondering what her next-door neighbor does for work. What does she think now?
Bob: She thinks that her neighbor is a programmer.

Having the opaque condition, which is predicted to show no difference between the two QUDs, helps us interpret a potential difference between the QUDs in the transparent condition.

2.3. Results

The above predictions are borne out in our experiment. Across the three stories, the opaque condition receives a high agreement rate regardless of the QUD, while the transparent condition receives a higher agreement rate with the existential QUD than with the *wh* QUD.

Figure 3 shows the distribution of responses by QUD and transparency in the three stories pooled together. On the left, the opaque conditions receive a high rate of "Agree" responses at over 90%, with both existential and *wh* QUDs. In contrast, on the right, the transparent condition shows a disparity in agreement rate between the two QUDs: while the majority accept the transparent condition under existential QUDs, its acceptance under *wh* QUDs is slightly below chance.

[10]The issue of question-answer congruency is also the reason why Ann's question is formulated in two sentences. While the existential question can be expressed by *Does Mia think that the apartment next door is vacant?* and the *wh* question as *What does Mia think her next-door neighbor do for work?*, our intuition is that these are much less congruent with the target attitude report, *She thinks that a programmer next door*, than the two-sentence inquiries used in the experiment.

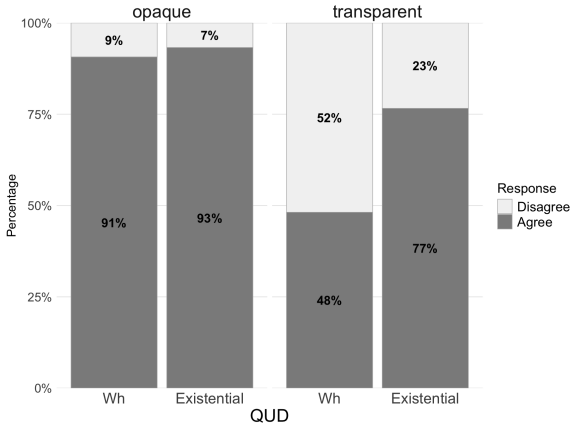

Figure 3: Distribution of responses by QUD and transparency across three stories.

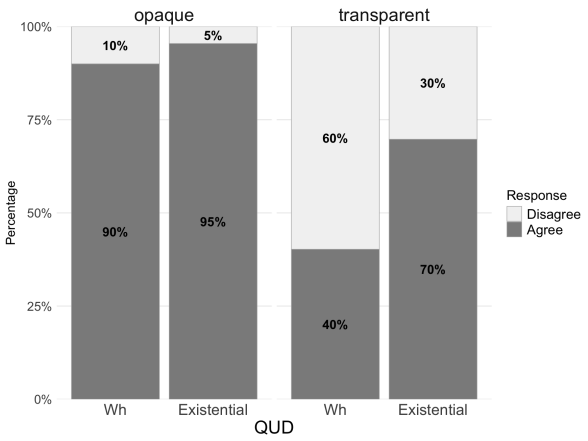

Figure 4: Story A.

We fit a Bayesian mixed-effects logistic regression model to the binary ratings (reference level = Disagree). The model included dummy-coded main effects for QUD (reference level = *wh*) and transparency (reference level = transparent) as well as their interaction, and a random intercept for story (rating ~ QUD * transparency + (1|story)). The model was implemented using the brms package (Bürkner, 2017) in R. Four chains were run with 6000 iterations each, including 3000 warm-up samples per chain, yielding 12000 post–warm-up draws in total. All parameters showed R-hat = 1.00, indicating convergence. For the focal contrasts (QUD, transparency, and the interaction), we used weakly informative Normal(0, 2) priors on the log-odds scale. For other parameters, brms' default priors were used. A prior sensitivity analysis comparing our model to a version with default priors shows that the inferences were not driven by the priors (difference < 0.2 for all the main effects and the intercept).

There is an effect of the QUD such that an existensial QUD is more likely to receive agreement (β = 1.24 (OR = 3.45), CI = [0.87, 1.63]), and a strong main effect of transparency such that the opaque condition is more likely to receive agreement (β = 2.36 (OR = 10.56), CI = [1.90, 2.86]). Crucially, there is also a small but significant interaction between QUD and transparency, such that the positive effect of an existential QUD is greater for the transparent condition than for the opaque condition (β = -0.84 (OR = 0.43), CI = [-1.56, -0.10]).

Inspection of individual stories (Fig. 4-6) reveals that the pattern is replicated across all three. Due to the smaller sample size, rather than fitting a logistic regression model, we ran Chi-square tests on the results from each story. In all three stories, the difference in agreement rates between the existential and *wh* QUDs is significant for the transparent condition and not for the opaque condition, after Bonferroni correction for multiple comparisons (Story A: χ^2=13.63, p<.001 for Transparent, χ^2=1.31, p=.51 for Opaque; Story B: χ^2=26.51, p<.001 for Transparent, χ^2=0.04, p=1.00 for Opaque; Story C: χ^2=5.41, p =.040 for Transparent, χ^2=0.43, p=1.00 for Opaque).

One noticeable difference is that only in Story B, the transparent condition is as good as the opaque condition under the existential QUD. See Section 3.1 for a discussion of why that may be.

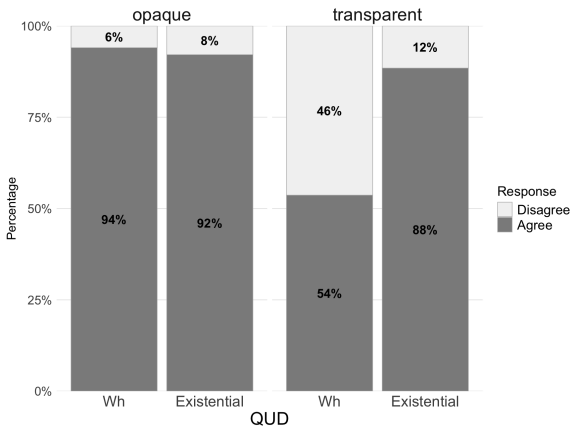

Figure 5: Story B.

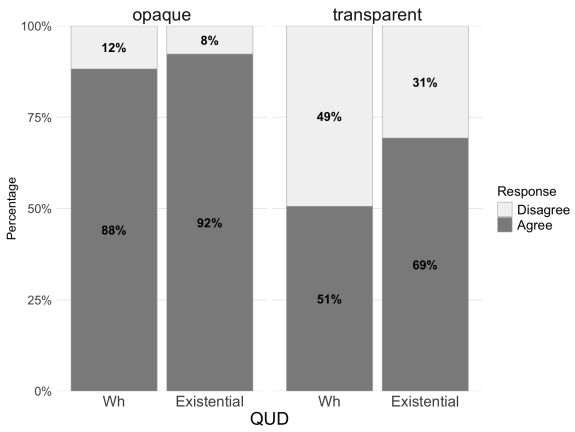

Figure 6: Story C.

3. Discussion

3.1. Theoretical insights and questions

Our results provide experimental support for Mayr and Schmitt's (2023; 2024) claim that an attitudinal existential QUD facilitates a transparent reading. This finding has theoretical consequences for replacement theories of transparent readings, although it cannot provide direct evidence for it, and alternatives remain viable. Here we discuss how the finding distinguishes the QUD-sensitive replacement theories by Percus (2020) and Mayr and Schmitt (2023, 2024).

The empirical motivation for Percus's (2020) replacement theory is his observation that a pseudo-*de re* reading seems acceptable when there is a factual QUD (see Section 1.2). To account for this observation, he proposes a mechanism in which the entire embedded proposition, only if at-issue, can be replaced by another proposition that is indeed believed by the attitude holder (with the all-opaque reading). In (16), this is implemented using a covert free variable over propositions, p_8, and a replacement device R, which replaces the prejacent, q with the value of p_8 iff q is at-issue in the context.

(16) a. x thinks that R p_8 [$_q$...]

b. $[\![R]\!]^{w,c} = \lambda p.\lambda q$: q is at-issue in c. p

Percus (2020) asks which cases of (more canonical) transparent readings are also generated by the replacement mechanism in (16), pointing out that it cannot be the only mechanism available. He notes that replacing the embedded proposition would not work if it is a contradiction (under the opaque reading) (17) (see also Mayr and Schmitt 2023).

(17) John thinks that everyone at the meeting is somewhere else.

Our finding of transparent readings facilitated by attitudinal existential QUDs present another case of transparent readings that cannot be derived by the mechanism, although for a slightly different reason than (17). In (17), both the definedness condition and the resulting denotation according to (16) would both be problematic. In contrast, in our data, only the definedness condition of (16) is problematic; if the definedness condition were to be revised to allow attitudinal existential QUDs, replacement of the entire embedded proposition would be able to derive a

well-formed truth condition.

Mayr and Schmitt (2023, 2024), in contrast, take the availability of transparent readings under attitudinal existential QUDs as empirical motivation for their theory. In their theory, what is assessed for at-issueness is the entire attitude report. Taking (4a) as an example, its assertion according to their account is that 'There is a replacement concept for 'Ann' such that Joe thinks$_{w'}$ Eve is involved with [replacement concept](w′)' (18).

(18) $[\![(4a)]\!]^{w,g,Q} = \exists f_{\langle e,se\rangle}[\forall w' \in \textsc{dox}_{J,w}$: Eve is involved with $[f([\![\text{Ann}]\!]^{w'})(w')]$ in w′]

The definedness condition is that the assertion would entail the same answer, p to the QUD, Q as the original attitude report with an opaque reading would (19).

(19) $\exists p \in Q[\ (\lambda w.\exists f_{\langle e,se\rangle}[\forall w' \in \textsc{dox}_{J,w}$: Eve is involved with $[f([\![\text{Ann}]\!]^{w'})(w')]$ in w′$]) \rightarrow p \wedge$
$(\lambda w.\ \forall w' \in \textsc{dox}_{J,w}$: Eve is involved with $[\![\text{Ann}]\!]^{w'}$ in w′$) \rightarrow p]$

Concretely, in (4a), the definedness condition is met because both the original attitude report (20a) and a revised version with *Ann* replaced with *the person dancing with her* would entail the same answer to the hypothesized QUD. The sentence is judged true on the basis of the latter being true (with an all-opaque reading).

(20) QUD: Does Joe think that Eve is single?
   a. Joe thinks that Eve is involved with **Ann**. → No
   b. Joe thinks that Eve is involved with **the person dancing with her**. → No

Other notable features of Mayr and Schmitt's analysis is that there is no LF distinction between opaque and transparent readings, with the replacement mechanism always present; and that this mechanism is generalized to various semantic types, including the descriptive content in a third reading as in our study. While the QUD conditions are compatible with our experimental results, in terms of the particular formal implementation, it is not clear to us how the use of a replacement concept can be extended to descriptive content (see Baron 2016 for discussions of this issue).

While our results narrow down the hypothesis space for what the definedness condition of a replacement approach should be, it should be stressed that they do not provide empirical evidence for replacement theories broadly against alternative accounts. For example, the results are compatible with transparent evaluation theories (von Fintel and Heim, 2011; Keshet, 2008; Demirok, 2019). Take an attitudinal existential QUD from Story A (21a), which essentially asks whether there is an individual x such that x lives next door in all of Mia's doxastic alternatives. The denotation of the target attitude report according to the transparent evaluation theories is provided in (21b), where *programmer* is evaluated at the evaluation world, w, rather than Mia's doxastic alternatives, w′.

(21) a. Existential QUD: Does M. think the apartment next door is vacant?
$\approx \{\lambda w.\ \forall w' \in \textsc{dox}_{M,w}$: $\exists x$[x lives next door in w′],
$\lambda w.\ \forall w' \in \textsc{dox}_{M,w}$: $\neg\exists x$[x lives next door in w′]$\}$
   b. $[\![$She thinks that a programmer lives next door$]\!]^{w,g} =$
$\forall w' \in \textsc{dox}_{M,w}$: $\exists x[[\![\text{programmer}]\!]^{w,g}(x) \wedge$ x lives next door in w′]

(21b) answers the QUD in (21a). All that matters for the QUD is the existence of an individual who lives next door according to Mia, and the occupation of that individual in any world is

irrelevant. In other words, a version of (21b) without the property of being a programmer, which would be equivalent to *Mia thinks that someone lives next door* (22), would resolve the QUD in (21a).

(22) $\forall w' \in \text{DOX}_{M,w}$: $\exists x[\sout{[\![\text{programmer}]\!]^{w,g}(x) \wedge}$ x lives next door in w′]

In short, coupled with an appropriate theory of how an attitude report addresses a QUD, transparent evaluation theories can account for the observed QUD-sensitivity of transparent readings just as well as replacement theories that hard-wire QUDs into the denotations of attitude reports.

There are two remaining questions. First, there is no obvious explanation for why the transparent condition under a *wh* QUD solicited an agreement rate of around 50% overall, and specifically in Story B and C. According to both QUD-sensitive replacement theories and transparent evaluation theories (with an appropriate view of QUD), an attitude report that is only true under a transparent reading of a descriptive content should not be felicitous as an answer to an attitudinal *wh* question concerning that content. Assuming that the manipulation of the QUD was just as successful in the relevant condition (Group 3) as in the other three groups, one possible explanation is that the participants came up with a different QUD in order to accept the sentence (see Section 3.2 for candidates for such alternative QUDs).

Second, the disparity between transparent and opaque conditions even under the attitudinal existential QUDs requires an explanation. Recall that in the overall results from the three stories as well as in Story A and C, the transparent condition with an existential QUD had only ≈70% agreement rates, compared to ≥90% agreement rates in the opaque condition. While we are not aware of any explicit theory for why transparent readings are intuitively harder to access than opaque readings, let's take Mayr and Schmitt's framework as an example. Mayr and Schmitt argue that transparent and opaque readings share one and the same LF, and replacement is always involved, even for opaque readings. If that is the case, why are transparent readings harder to access? One possible explanation is that non-trivial replacements are costly (p.c. Viola Schmitt). When the attitude report in Story A is true with an opaque reading of *programmer*, 'programmer' can be the only replacement concept (23a). On the other hand, even under the existential QUD, a transparent reading of the string-identical attitude report requires a non-trivial replacement concept such as 'person Mia saw in the hallway' because the non-trivial replacement would yield the attitude report false (23b).

(23) QUD: Does Mia think that the apartment next door is vacant?
She thinks that a programmer lives next door.
   a. Opaque reading: $f([\![\text{programmer}]\!]^{w'})(w') = [\![\text{programmer}]\!]^{w'}$
   b. Transparent reading: $f([\![\text{programmer}]\!]^{w'})(w') = [\![\text{person Mia saw in the hallway}]\!]^{w'}$

Still, prior experimental work suggests that transparent readings are not always harder to access than opaque readings. Zhang and Davidson (2024) tested definite DPs with a possessive structure (e.g., *Elizabeth's poem*) and demonstrated that in contexts analogous to those of the current study, there is no significant difference in the acceptability judgements between transparent and opaque readings. An example stimulus from Zhang and Davidson's study is provided in (24).

(24) Story: Julie is a judge of an ongoing poetry competition. She encounters an extremely well-written poem and believes that this poem will be the winner of the competition. This poem happens to be written by Elizabeth Johnson, a well-known poet in the US. But unfortunately, as a judge, Julie is blind to the authors and therefore does not know it

is Elizabeth Johnson who wrote this excellent poem.
According to this story, please indicate to what extent you agree or disagree with the following statement. (five-point Likert scale)
Julie believes that Elizabeth's poem will win the competition.
(adapted from Zhang and Davidson, 2024:18 Tab.2)

There are two (non-mutually exclusive) possible explanations for the disparity between transparent and opaque readings in our study but not in Zhang and Davidson (2024). The first is that a third reading, or a transparent reading of a descriptive content in general, is harder to access than the transparent reading of an entity-denoting expression. The second possibility is that an implicit QUD that facilitated the transparent reading in (24) is not an attitudinal existential question. (24) does not directly control the QUD, and crucially, a factual QUD such as "Who will win the competition?" is not only available but fairly accessible in the context. In contrast, factual QUDs were intentionally ruled out in our study. Therefore it is possible that factual QUDs facilitate transparent readings even better than attitudinal existential QUDs.

Related to the second point, the possibility that acceptability of transparent readings in experimental settings is dependent on not only the availability but saliency of a compatible QUD(s) relative to other candidate QUDs is also evident in our results. Recall that, only in Story B, the agreement rate for the transparent condition under the existential QUD was just as high as for the opaque condition. We suggest that this is because, looking at attitudinal existential QUD conditions across the stories, an alternative, attitudinal *wh* question was less likely to arise in Story B than in the other two Stories. The existential QUD * transparent condition (Group 1) from Story B is presented in (25).

(25) Two days ago, Emily started working as an administrative assistant at a large corporation. She was assigned to a small corner cubicle. The cubicle next to hers seemed much more spacious, so she was wondering if it is available for her to take. It is in fact available, but Emily didn't know that for a fact. Yesterday, when she was leaving the office in a hurry, Emily saw a group of men gathering in front of that next cubicle. Although Emily doesn't know it, these men are all accountants who work on a different floor, and they only came to her floor to use a coffee machine. Now Emily thinks that one of the men she saw yesterday works in the next cubicle, although she isn't sure which man.

Ann. I read that Emily was wondering if the cubicle next to hers is available. What does she think now?

Bob. She thinks that an accountant works in the next cubicle.

In (25), Emily has a stake in whether the next cubicle is available because if it is, she wants to use it. Compare this with Story A (1); in that story, Mia is similarly wondering about the potential vacancy of the next-door apartment, but there is no explicit mention of what she would do upon finding out the answer either way. We suggest that Story B was more successful in ruling out an alternative, attitudinal *wh* question, in this case *What job does Emily think the person who works in the next cubicle has?* because of the high stake Emily has in the next cubicle being empty; once she finds that it is not empty, she is unlikely to be interested in the properties of the person who uses it. In contrast, in Story A, Mia is interested in the state of the next-door apartment without a particular stake in it being vacant. Compared to Story B, it is more probable that Mia would be interested in follow-up questions about the person, she comes to think, occupies the space, as in the *wh* question *What does Mia think her next-door neighbor does for work?*

The above discussion both illustrates the delicate nature of QUD manipulation and raises an issue that there is no foolproof way to ensure that the participants access only the intended QUD. Nevertheless, the replication of the core pattern across the three stories indicates that there were elements of the stories that contributed to successfully controlling the QUD. The next section discusses the insights we gained on manipulating the QUD about someone's mental state in experimental settings.

3.2. Methodological insights

What were the shared properties of the three stories that aided the manipulation of the QUD? First, in order to motivate Ann's question to Bob, there must be a knowledge gap between them. In existing experimental studies that directly manipulate the QUD in a dialogue, this is done by limiting access of one agent to visual (Cremers et al., 2017; Ronai and Xiang, 2021; Grusdt et al., 2023) and auditory (Evcen et al., 2025) information, or placing a dialogue in a situation where a knowledge gap is expected, such as between a judge and a witness in a courtroom (Westera and Brasoveanu, 2014). In the current study, a knowledge gap between Ann and Bob had to be with respect to someone's mental state, which is not as easily observable in visual or auditory contexts. While it is possible to make an inference about the protagonist's beliefs based on what they utter, such a method may bias the participants to choose an attitude report that matches the linguistic form of the protagonist's utterance, which would favour an opaque reading. Instead, we created a knowledge gap by setting up a context with a story and limiting one interlocutor's (Ann's) access to the part of the story that discusses the protagonist's beliefs. To our knowledge, this is a novel method for manipulating a QUD about someone's mental state.

Second, the protagonist's beliefs had to be foregrounded in order to raise a question about it. To do this, we took hints from studies on acquisition of attitude reports (Lewis et al., 2012; Hacquard and Lidz, 2019). In these studies, in order to foreground the protagonist's belief, another agent with an opposite belief was added to the context; this manipulation helped children access adult-like truth value judgements of attitude reports by highlighting the relevance of beliefs. In our setting, since adding another agent would make the stories even longer, we instead set up a context in which the protagonist's belief state changes over the course of the story. For example, in the existential QUD * transparent condition (Group 1) in Story A ((26) repeated from Fig. 1, (9)), in the beginning, Mia actively considers the possibility that the next-door apartment is vacant by wondering whether that is the case, where it is indeed the case unbeknownst to her. Later in the story, she gains a wrong belief that the apartment isn't vacant.

(26) Mia moved into a new apartment last week. Her floor is very quiet, so she was wondering if the apartment next door is vacant. It is in fact vacant, but Mia didn't know that for a fact. Yesterday, before she left to go furniture shopping for her new apartment, Mia saw a group of three men in the hallway. The men were each viewing the apartment next door, and they all happened to be programmers. However, Mia didn't know any of that. Now Mia thinks that one of the men she saw in the hallway yesterday lives in the apartment next door, although she isn't sure which man.

Ann. I read that Mia was wondering if the apartment next door is vacant. What does she think now?

Bob. She thinks that a programmer lives next door.

In the *wh* QUD condition, too (11), the protagonist gains a wrong belief in that none of the people that Mia saw and believe to potentially live next door actually live there. We suggest that this change of belief resulting in a wrong belief helps foreground questions about beliefs.

Related to the second point, in the existential QUD condition, our formulation of the sentence *x was wondering if p*, which is present in all three stories, makes the intended attitudinal existential QUD salient relative to the attitudinal *wh* question. To illustrate, in (26), the sentence is formulated as (27a), not (27b), even though the overtly expressed propositions in the embedded clauses are merely negations of each other, and hence Mia reaches her answer to both of them in the story.

(27) a. She was wondering if the apartment next door is vacant.
b. She was wondering if anyone lives in the apartment next door.

The reason we chose (27a) is due to the intuition that in *x wonders if p*, p is more interesting or consequential to x than ¬p (Eckardt, 2008). Eckardt, building on Bolinger (1978), makes the generalization in (28).

(28) The Bias of *if*: The use of an embedded if S presupposes that the two possible answers are not of equal status for future actions, opinions, plans, etc. Commonly, the positive case S is the relevant case for some decision, opinion, etc., the case that really changes something. The negative case is perceived as the 'otherwise' case with no, or no interesting consequences. (Eckardt, 2008: 9(24))

In (26), the proposition that the apartment next door is vacant is the interesting case, and its negation, that someone lives in the apartment next door, is the 'otherwise' case. Our intention for making the vacancy more interesting to Mia was to rule out an attitudinal *wh* question as much as possible. If Mia were instead interested in whether anyone lives next door, upon coming to the conclusion that someone does live next door, she would be more likely to be interested in follow-up questions about that resident, including what they do for work. Of course, the possibility that Mia would be interested in the *wh* question is not completely ruled out in our design (see Section 3.1), but we believe that this manipulation maximized the saliency of the existential QUD relative to the *wh* question.

In the *wh* QUD condition, ruling out the QUD of the other condition, an existential QUD, is much more straightforward: the story simply stated what would be an answer to such a question, in the part that both Ann and Bob had access to. For instance, in (11), the sentence *She knew that the apartment next door is occupied* rules out an existential QUD, 'Does Mia think that the apartment next door is vacant?'

Finally, since we were specifically interested in the potential difference between different attitudinal QUDs, it was important that the corresponding factual QUDs were ruled out. This was done by stating the fact that would resolve the factual QUD, again in the first part of the story that was accessible to both Ann and Bob. In the attitudinal existential QUD condition (26), a factual existential question, 'Is the apartment next door vacant?,' was ruled out by stating, *It is in fact vacant, but Mia didn't know that for a fact*. Similarly, in the attitudinal *wh* QUD condition (11), a factual *wh* question, 'What does Mia's next-door neighbor do?,' was ruled out by the sentence, *Unbeknownst to Mia, her neighbor is actually a carpenter*.

In summary, the recipe we found for motivating and manipulating an attitudinal QUD includes creating a knowledge gap between discourse agents by giving them access to different parts of

a story, foregrounding the protagonist's belief by making them acquire a wrong belief in the course of the story, and ruling out alternative attitudinal and factual QUDs by making them less salient or resolving them in the story.

4. Conclusion

This paper presented the first experimental evidence for the hypothesis that the acceptability of an attitude report that is only true under a transparent reading is dependent on the question under discussion (QUD) (Schwager, 2009; Percus, 2020; Benbaji-Elhadad, 2023; Mayr and Schmitt, 2023, 2024). In particular, it provided support for Mayr and Schmitt's introspective judgement that attitudinal QUDs, that is, questions about the attitude holder's mental state, differ in their ability to license transparent readings. A theoretical consequence of this finding is that a replacement mechanism that requires at-issueness of the attitude complement (Percus, 2020) cannot be the only mechanism for deriving transparent readings, a conclusion that Percus himself reaches based on a different data point. This finding contributes to the ongoing debate about what the exact definedness condition should be if we were to pursue the replacement-based accounts of transparent readings (Schwager, 2009; Sudo, 2014), especially those that hard-wire QUDs into the semantics (Percus, 2020; Benbaji-Elhadad, 2023; Mayr and Schmitt, 2023, 2024). On a methodological side, we offered a detailed explanation of the properties of the stimuli that facilitated fine-grained manipulation of the QUD in our experiments.

Remaining questions that may be addressed by further experimental studies include whether factual QUDs support transparent readings more easily than attitudinal existential QUDs; whether there is a difference between expressions of different semantic types (see Zhang and Davidson 2021, 2024 on entity-denoting expressions) in the acceptability of transparent readings when the context and the QUD are controlled for; and why transparent readings seem to be at least sometimes harder to access than opaque readings.

Finally, the methodology of QUD manipulation developed in this paper may be useful in answering more nuanced questions about the potential interactions between the QUD and other contextual factors, such as the knowledge state of the attitude holder. Sudo (2014:447-448) notes that there are two kinds of contexts that may give rise to an unambiguously transparent reading of a given expression; *ignorance* contexts are those in which "the attitude holder is ignorant about the identity of the referent," as in the stories for the transparent condition in our study, and *misapprehension* contexts are those in which "the attitude holder is wrong about the identity of the referent," as in the stories for the opaque condition in our study. Against this background, Zhang and Davidson (2024) provide experimental evidence that *de re* readings of entity-denoting expressions are more available in the former than the latter contexts, and suggest that an implicit QUD may be a factor in this gap. In the theoretical literature, Benbaji-Elhadad (2023) proposes yet another replacement theory in which whether the QUD plays a role in the condition on replacement is dependent on the attitude holder's knowledge state. We believe that an experiment that uses the set up of our study and tests the availability of transparent readings by crossing the QUD with the attitude holder's knowledge state would shed light on the relationship between these two kinds of contextual effects.

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