The crucial trigger for illusory licensing of *wh*-phrases in Japanese is prediction error, but not retrieval cues themselves

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In Japanese, interrogative *wh*-phrases (e.g., *dono*) and Q(uestion)-particles (e.g., *ka*/*no*) form a syntactic dependency; *wh*-phrases need to be c-commanded by a Q-particle [1]. Hence, sentence (1) is ungrammatical, as the *wh*-phrase *dono* 'which' in the matrix clause is not c-commanded by the Q-particle *-ka* in the embedded clause [2]. However, it has been shown that sometimes native Japanese speakers erroneously accept such ungrammatical sentences as (1) in speeded acceptability judgments (the illusion of grammaticality) [3].

One possible account for the grammatical illusion in Japanese *wh*-sentences based on cue-based memory retrieval is that the embedded Q-particle *-ka*, which serves as a potential retrieval cue for *wh*-phrases, triggers a misretrieval of the matrix *wh*-phrase 'which,' leading to illusory *wh*-Q dependency formation [Hypo. 1] [4]. The other possibility is that a mismatch between predictions and actual inputs triggers the misretrieval of the *wh*-phrase [5]. For instance, in (1), although the matrix *wh*-phrase predicts a Q-particle in the matrix clause (the sentence-final position), no Q-particle is provided there, indicating the mismatch between the prediction and the input, which triggers the misretrieval of the matrix *wh*-phrase [Hypo. 2].

This study tested these hypotheses by conducting two self-paced reading experiments, where two factors were crossed: MATRIX SUBJECT (*wh*/non-*wh*) × EMBEDDED COMPLEMENTIZER (Q/DECL). The difference between the experiments was whether or not the matrix clause contained a Q-particle; only sentences in Exp. 1 contained a Q-particle in the matrix clause (2).

Hypo. 1 expects a reading time (RT) speedup (a facilitatory interference) for the embedded verb *kinyuusiteita-ka* 'wrote down-Q' (R5) in (a) relative to (c) in both experiments. This is because the embedded Q-particle *-ka* in (a) would trigger a misretrieval of the matrix *wh*-phrase *dono-kenkyuuin* 'which researcher' [6]. Furthermore, Hypo. 1 expects an RT slowdown (an inhibitory interference) for R5 in (d) compared to (b) in both experiments because the declarative complementizer *-to* in (d) would retrieve both the matrix and embedded non-*wh*-subjects, *sono-kenkyuuin* 'that researcher' and *asisutanto* 'assistant,' inducing cue overload. For a detail of the retrieval processes, see the third page of this abstract.

On the other hand, Hypo. 2 does not expect an RT differences for R5 because no prediction-error is expected in this region. Instead, Hypo. 2 expects an RT difference in R7 (the matrix verb *kiita* 'asked'), specifically an RT speedup (a facilitatory interference) in (a) compared to (b) only in Exp. 2, because the prediction-error occurs in this region only in Exp. 2 (3). In (3a/b), it turns out that there is no Q-particle in the matrix clause (the sentence-final position), although one has been predicted by the matrix *wh*-phrase. This prediction-error would trigger the illusory dependency formation in (3a) because of the existence of the Q-particle in the embedded clause, resulting in a facilitatory interference (a race process). On the other hand, in (3c/d), no RT difference is expected because there is no prediction-error so that no retrieval process is expected to occur.

Log-transformed RT data were analyzed using linear mixed-effects models. By-subject mean log RTs in R5 and R7 for Exps. 1 and 2 are presented in Fig. 1 and 2, respectively. Exp.1 (n=44) exhibited neither an RT speedup nor slowdown for R5. Rather, RTs in (2a) and (2c) were longer than in (2b) and (2d) (t=−2.263, p=0.023). These results are inconsistent with Hypo. 1. Exp. 2 (n=32) showed the similar RT pattern in R5 (t=−2.855, p=0.004). Crucially, however, it revealed an RT speedup in R7 (a significant interaction of the two factors: t=−3.397, p=0.002). Pairwise comparisons further revealed that RTs in (3a) were shorter than in (3b) (t=3.103, p=0.001) and RTs in (3c) were longer than in (3d) (t=−3.624, p<0.001). The RT speedup in (3a) can be seen as the facilitatory interference due to the illusory licensing of the matrix *wh*-phrase. This is consistent with Hypo. 2. The unexpected RT slowdown in (3c) is likely to reflect the unexpected ungrammaticality of the sentences in this condition. We assumed that sentences (3c) and (3d) were both perfectly grammatical, so we did not expect an RT difference between them. However, it is reported that the acceptability of (3c) was unexpectedly lower than that of (3d) [3]. Hence, the RT slowdown in R7 in (3c) might be attributed to its ungrammaticality.

To summarise, the results together demonstrate that a facilitatory interference due to illusory licensing of *wh*-phrases in Japanese occurs only when it turns out that there is a mismatch between predictions and actual inputs. Thus, we conclude that prediction-error, not potential retrieval cue itself, triggers illusory licensing of *wh*-phrases in Japanese.

(1) *__Dono__-kenkyuuin-ga [asisutanto-ga kenkyuusitu-de deeta-o
__Which__-researcher-NOM [assistant-NOM laboratory-LOC data-ACC
kinyuusiteita-__ka__] jimuin-ni itta.
wrote-down-__Q__] clerk-DAT told.
'Which researcher told the clerk whether the assistant wrote down the data at the laboratory.'

(2) **Example stimuli in Exp. 1:** All sentences are grammatical. The subscripted numbers indicate region numbers

a. __Dono__-kenkyuuin-ga$_1$ [asisutanto-ga$_2$ kenkyuusitu-de$_3$ deeta-o$_4$
__Which__-researcher-NOM$_1$ [assistant-NOM$_2$ laboratory-LOC$_3$ data-ACC$_4$
kinyuusiteita-__ka__$_5$] jimuin-ni$_6$ itta-__no__?$_7$
wrote-down-__Q__$_5$] clerk-DAT$_6$ told-__Q__?$_7$

b. __Dono__-kenkyuuin-ga$_1$ [asisutanto-ga$_2$ kenkyuusitu-de$_3$ deeta-o$_4$
__Which__-researcher-NOM$_1$ [assistant-NOM$_2$ laboratory-LOC$_3$ data-ACC$_4$
kinyuusiteita-to$_5$] jimuin-ni$_6$ itta-__no__?$_7$
wrote-down-DECL$_5$] clerk-dat$_6$ told-__Q__?$_7$

c. Sono-kenkyuuin-ga$_1$ [asisutanto-ga$_2$ kenkyuusitu-de$_3$ deeta-o$_4$
That-researcher-NOM$_1$ [assistant-NOM$_2$ laboratory-LOC$_3$ data-ACC$_4$
kinyuusiteita-__ka__$_5$] jimuin-ni$_6$ itta-__no__?$_7$
wrote-down-__Q__$_5$] clerk-DAT$_6$ told-__Q__?$_7$

d. Sono-kenkyuuin-ga$_1$ [asisutanto-ga$_2$ kenkyuusitu-de$_3$ deeta-o$_4$
That-researcher-NOM$_1$ [assistant-NOM$_2$ laboratory-LOC$_3$ data-ACC$_4$
kinyuusiteita-to$_5$] jimuin-ni$_6$ itta-__no__?$_7$
wrote-down-DECL$_5$] clerk-DAT$_6$ told-__Q__?$_7$

(3) **Example stimuli in Exp. 2**: Sentences (a) and (b) are ungrammatical.

a/b. *__Dono__-kenkyuuin-ga$_1$ [asisutanto-ga$_2$ kenkyuusitu-de$_3$ deeta-o$_4$
__Which__-researcher-NOM$_1$ [assistant-NOM$_2$ laboratory-LOC$_3$ data-ACC$_4$
kinyuusiteita-^{a}__ka__/^{b}to$_5$] jimuin-ni$_6$ itta.$_7$
wrote-down-^{a}__Q__/^{b}DECL$_5$] clerk-DAT$_6$ told.$_7$

c/d. Sono-kenkyuuin-ga$_1$ [asisutanto-ga$_2$ kenkyuusitu-de$_3$ deeta-o$_4$
That-researcher-NOM$_1$ [assistant-NOM$_2$ laboratory-LOC$_3$ data-ACC$_4$
kinyuusiteita-^{c}__ka__/^{d}to$_5$] jimuin-ni$_6$ itta.$_7$
wrote-down-^{c}__Q__/^{d}DECL$_5$] clerk-DAT$_6$ told.$_7$

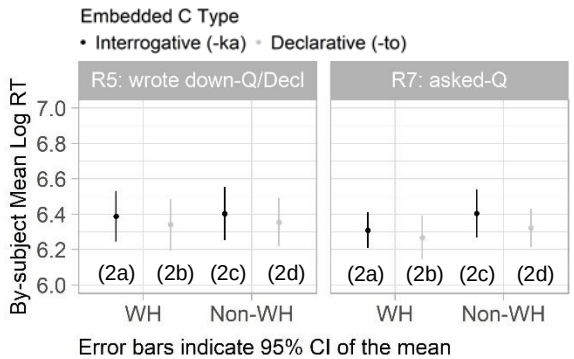

Fig. 1 By-subject Mean Log RT in Exp. 1

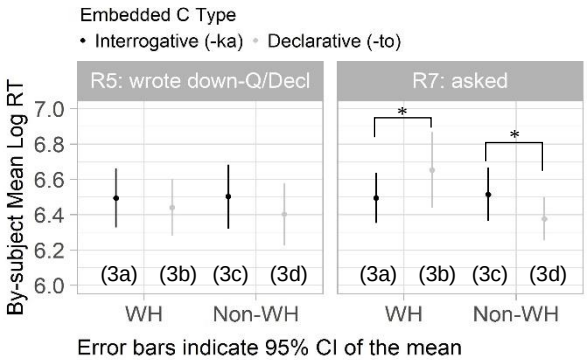

Fig. 2 By-subject Mean Log RT in Exp. 2

References

[1] Harada (1972) *Studies in Descriptive and Applied Linguistics* 5, 180–206. [2] Saito (1985) Ph.D. dissertation, MIT. [3] Minemi & Hirose (2019) *IEICE Technical Reports* 119(151), 83–88. [4] Lewis & Vasishth (2005) *Cog Sci* 29, 375–419. [5] Wagers et al. (2009) *JML* 61, 206–237. [6] Raab (1962) *Transactions of the New York Academy Sciences* 24, 574–590.

Exp. 1. The subscripted numbers indicate region numbers.

a. **Wh**-NOM$_1$ [+Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V-**Q**$_5$ [+Q] [−MATRIX]] … V-**Q**?$_7$ [+Q] [+MATRIX]
b. **Wh**-NOM$_1$ [+Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V-DECL$_5$ [−Q] [−MATRIX]] … V-**Q**?$_7$ [+Q] [+MATRIX]
c. NonWh-NOM$_1$ [−Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V-**Q**$_5$ [+Q] [−MATRIX]] … V-**Q**?$_7$ [+Q] [+MATRIX]
d. NonWh-NOM$_1$ [−Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V- DECL$_5$ [−Q] [−MATRIX]] … V-**Q**?$_7$ [+Q] [+MATRIX]

Hypo. 1 expects that an input of the embedded complementizer (Q/DECL) serves as a retrieval cue. The embedded interrogative complementizer Q in conditions (a) and (c) is assumed to have [+Q] and [−MATRIX] features, which correspond to the [+Q] feature of the matrix subject and the [−MATRIX] feature of the embedded subject, respectively. Thus, in condition (a), when the interrogative complementizer is processed, two retrieval processes triggered by different features, either [+Q] or [−MATRIX], would occur in parallel (a race process [6]), resulting in an RT speedup (a facilitatory interference) in this region (R5). On the other hand, in condition (c), although the same complementizer appears in the region, no preceding element has the corresponding feature to [+Q]. Hence, no race process is expected to occur in this condition.

The embedded declarative complementizer DECL in conditions (b) and (d) is assumed to contain [−Q] and [−MATRIX] features. In condition (b), the embedded subject has [−Q] and [−MATRIX] features. However, in condition (d), the matrix subject, as well as the embedded subject, has the [−Q] feature. Therefore, two retrieval processes triggered by the same type of retrieval cue [−Q] target different elements, leading to an RT slowdown (an inhibitory interference/ cue overload). To summarise, Hypo. 1 expects the RT speedup for R5 in condition (a) relative to (c) and the RT slowdown in condition (d) relative to (b).

In contrast, Hypo. 2 expects no such RT differences for Exp. 1 since all the sentences are grammatical. This hypothesis assumes that a critical trigger for cue-based retrieval in sentence comprehension is a mismatch between predictions and actual inputs. The matrix *wh*-subject predicts a Q-particle in the matrix clause, and the Q-particle actually appears there.

The result showed RT difference neither in R5 nor in R7. Thus, Hypo. 1 is not borne out.

Exp. 2. The subscripted numbers indicate region numbers.

a. ***Wh**-NOM$_1$ [+Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V-**Q**$_5$ [+Q] [−MATRIX]] … V$_7$ [−Q] [+MATRIX]
b. ***Wh**-NOM$_1$ [+Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V-DECL$_5$ [−Q] [−MATRIX]] … V$_7$ [−Q] [+MATRIX]
c. NonWh-NOM$_1$ [−Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V-**Q**$_5$ [+Q] [−MATRIX]] … V$_7$ [−Q] [+MATRIX]
d. NonWh-NOM$_1$ [−Q] [+MATRIX] [NonWh-NOM$_2$ [−Q] [−MATRIX] … V- DECL$_5$ [−Q] [−MATRIX]] … V$_7$ [−Q] [+MATRIX]

Sentences (a) and (b) in Exp. 2 are ungrammatical because there is no Q-particle in the matrix clause although the matrix *wh*-subject requires one there. Hypo. 1 expects the same RT difference in the embedded verb region (R5) for Exp. 2 as Exp. 1 because there is no change except the sentence-final position. The input of the interrogative complementizer Q in R5 in condition (a) would trigger a misretrieval of the matrix *wh*-subject due to a partial match of the retrieval cue [+Q], resulting in an RT speedup in this condition (a race process). In condition (d), the [−Q] feature of the embedded declarative complementizer would give rise to a misretrieval of the matrix subject, leading to an RT slowdown due to cue overload. In sum, the RT speedup is expected for (a) compared to (c) and the RT slowdown for (d) compared to (b).

By contrast, Hypo. 2 expects an RT speedup in condition (a) in R7, not in R5. In sentences (a) and (b), the matrix *wh*-subject predicts a Q-particle in the matrix clause, but there is no Q-particle, signaling a prediction-input mismatch. The mismatch would provoke the cue-based retrieval system. Then, it is the matrix *wh*-subject that serves as a retrieval cue because it requires a Q-particle; the *wh*-subject is interrogative, so it depends on Q-particles. In sentence (a), the embedded clause contains the Q-particle, which matches the retrieval cue [+Q]. In addition, the matrix clause has the [+MATRIX] feature. Thus, in condition (a), there would occur a race process, resulting in an RT speedup (a facilitatory interference). On the other hand, in condition (b), there is no Q-particle that partially matches the retrieval cue, so there would be no RT speedup. Furthermore, in sentences (c) and (d), there is no *wh*-phrase, and therefore, no retrieval process would occur. To sum up, Hypo. 2 expects the RT speedup for R7 in condition (a) relative to (b) and no RT difference between conditions (c) and (d).

The results demonstrated the RT speedup only in R7 in condition (a) compared to (b), and there was no RT difference between conditions (c) and (d). Thus, Hypo. 2 should be supported by the results of Exp. 2.