

Sluicing and Fragments in Korean: A Direct Interpretation Approach

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Outline of the Talk

- 1 Introduction
- 2 The Data: Merger and Sprouting in Korean
 - Similarities
 - Differences
- 3 Three Possible Approaches
 - Deletion Approach
 - LF Copying and Re-use Approach
 - Direct-Interpretation Approach
- 4 The Identity Issue
 - Semantic Identity
 - Syntactic Identity
- 5 An Analysis: Direct Interpretation and Question under Discussion
 - Basic Assumptions and Theory of Dialogue
 - Matrix Sluicing as Nominal Fragments
 - Embedded Sluicing as Predicate Fragments
 - Further Welcoming Consequences
- 6 Conclusion
- 7 Selected References

Two different types of sluicing in English

- *merger*: The remnant *wh*-phrase has an overt correlate (underlined) and the expression within the bracket is understood to be missing or elided:
 - (1) a. He looked like someone I know, but I can't think **who** <he looked like>.
 - b. We always knew he would succeed at something, but we didn't know **what** <he would succeed at>.

- *sprouting*: the first clause includes no overt correlate for the *wh*-remnant:
 - (2) a. She is complaining, but we don't know about **what** <she is complaining>.
 - b. Unfortunately, the supply seems to have dried up. I don't know **why** <the supply has dried up>.

Two types of sluicing in Korean

- merger type:

- (3) ku-nun nwukwunka-lul talm-ass-nuntey, **nwukwu**-i-nci
 he-TOP someone-ACC resemble-PST-but who-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 'He resembled someone, but I do not know who.'

- sprouting type:

- (4) ches khisu-lul ha-yess-nuntey, **nwukwu-wa**-i-nci
 first kiss-ACC do-PST-but who-with-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 '(I) did the first kiss, but I don't know with whom.'

three main questions

- The syntactic question inquires if there is any syntactic structure for the elided parts in sluicing that are given in the context.
- The identity question concerns the relationship between the understood material in ellipsis and its antecedent, focusing on the question of whether the identity relation is syntactic or semantic.
- The licensing question looks into what allows for the ellipsis of the missing material in sluicing.

three main approaches in answering these

- PF-deletion (Ross 1969, Merchant 2001, Fox and Lasnik 2003): posits ordinary syntax which undergoes some kind of deletion and renders the syntax unpronounced.
- LF-copying (Lobeck 1995, Chung et al. 1995, 2010, Chung 2006, 2013): the ellipsis site has a null lexical element which is replaced or identified at some level of representation, say, LF.
- Direct Interpretation (DI) approach (Ginzburg and Sag 2000, Culicover and Jackendoff 2005, Sag and Nykiel 2011, Nykiel 2013): there is no syntactic structure at the ellipsis site other than the *wh*-phrase.

Embedded Q-slucing

- the obligatory presence of the copula verb *i-* followed by the interrogative-clause marker *-(nu)nci* (or *-nyako*).
- the interrogative complementizer *-(nu)nci* is attached only to the head of a clausal expression selected by interrogative verbs

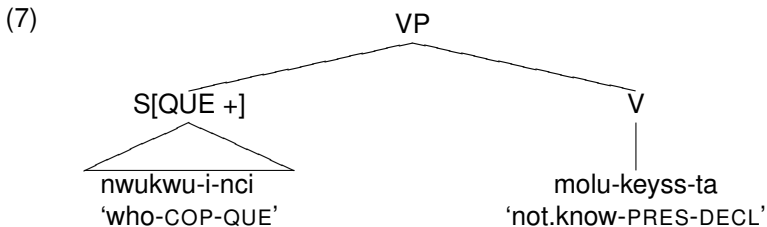
- (5) a. John-un [Mary-ka mwues-ul sa-ss-nunci/*ta-ko]
 John-TOP Mary-NOM what-ACC buy-PST-QUE/DECL-COMP
 molla-ss-ta.
 not.know-PST-DECL
 'John didn't know what Mary bought.'
- b. John-un [Mary-ka ku chayk-ul
 John-TOP Mary-NOM the book-ACC
 sa-ss-ta-ko/*nunci] malha-yess-ta.
 buy-PST-DECL-COMP/QUE say-PST-DECL
 'John told us that Mary bought the book.'

Embedded Q-slicing

- a typical sluicing example again:

(6) Mimi-ka ecey nwukwunka-lul manna-ss-nuntey,
 Mimi-NOM yesterday someone-ACC meet-PST-but
nwukwu-i-nci molu-keyss-ta.
 who-COP-QUE not.know-PRES-DECL
 'Mimi met someone yesterday, but I do not know who.'

- a clausal structure of the fragment



Unrealized subject

- The unrealized subject of the *wh*-remnant clause can be replaced by the pronoun *kukey* 'it' (short form of *ku kes-i* 'the thing-NOM') in both merger and sprouting
- (8) a. Mimi-ka nwukwunka-lul manna-ss-nuntey, (kukey)
 Mimi-NOM someone-ACC meet-PST-but it
nwukwu-i-nci molu-keyss-ta.
 who-COP-QUE not.know-PRES-DECL
 'Mimi met someone, but I do not know who (it is).'
- b. Mimi-ka senmwul-ul pat-ass-nuntey, (kukey)
 Mimi-NOM present-ACC receive-PST-but it
nwukwu-lopwuthe-i-nci molu-keyss-ta.
 who-from-COP-QUE not.know-PRES-DECL
 'Mimi received a present (from someone), but I do not know from whom.'

the pronoun *kukey*

- the pronoun *kukey* in (8a) appears to refer to the animate correlate *nwukwunka-lul* 'someone-ACC', but in non-slucing environments it refers to either a nonanimate entity or a situation.

- (9) a. Mimi-ka nwukwunka-lul manna-se, *kukes-kwa
 Mimi-NOM someone-ACC meet-CONN the.thing-with
 iyakiha-yess-ta.
 talk-PST-DECL
 'Mimi met someone, and talked with him.'
- b. Mimi-ka sihem-ey ttelecye-ess-nuntey, kukey mit-e
 Mimi-NOM exam-at fail-PST-but it believe-CONN
 ci-ci anh-nun-ta.
 become-CONN not-PRES-DECL
 'Mimi failed the exam, but it was unbelievable.'

indefinite correlate

- the correlate of a *wh*-remnant is in general an indefinite, introducing a variable

- (10) a. Mimi-ka nwukwunka-eykey ku chayk-ul cwu-ess-nuntey,
 Mimi-NOM someone-DAT the book-ACC give-PST-but
 nwukwu-i-nci molu-keyss-ta.
 who-COP-QUE not.know-PRES-DECL
 ‘Mimi gave the book to someone, but I do not know who.’
- b. *Mimi-ka chesccay tongsayng-eykey ku chayk-ul
 Mimi-NOM first sister-DAT the book-ACC
 cwu-ess-nuntey, nwukwu-eykey-i-nci molu-keyss-ta.
 give-PST-but who-DAT-COP-QUE not.know-PRES-DECL
 ‘*Mimi gave the book to the first sister, but I do not know who.’

multiple sluicing

- The literature has noted that multiple sluicing has a marginal status in English:
 - (11) a. ?Someone talked about something, but I can't remember who about what.
 - b. ?Mary showed something to someone, but I don't know exactly what to whom. (Lasnik 2014: 8)

multiple sluicing

- Korean is much more generous in allowing multiple sluicing (see, among others, Sohn 2000, Park 2007, Kim, S. 2012, Kim and Sells 2013a, 2013b, Yoo 2013):

- (12) a. Mimi-ka ecey mwuesinka-lul nwukwunka-eykey
 Mimi-NOM yesterday something-ACC somebody-DAT
 cwu-ess-nuntey, **mwues-ul nwukwu-eykey-i-nci**
 give-PST-but what-ACC who-DAT-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 ‘Mimi gave something to someone yesterday, but I do not know what to whom.’
- b. pemin-i cap-hi-ess-nuntey, **encey**
 criminal-NOM catch-PASS-PST-but when
nwukwu-eykey-i-nci molu-keyss-ta.
 who-by-COP-QUE not.know-PRES-DECL
 ‘The criminal was caught, but I don’t know by whom and when.’

case matching connectivity

- Sluicing also requires case matching effects, displaying a connectivity effect between the *wh*-remnant and its correlate, as noted by Ross (1969) for German and restated in Merchant (2001, 2006, 2012).

(13) Er will jemandem schmeicheln, aber sie wissen nicht,
 he wants someone.DAT to.flatter but they know not
 wem/*wen.
 who.DAT/who.ACC
 'He wants to flatter someone, but they don't know who.'

case matching connectivity

- (14) a. Mimi-nun nwukwunka-eykey honna-ss-nuntey,
 Mimi-TOP someone-DAT be.scolded-PST-but
nwukwu-eykey/*lul-i-nci molu-keyss-ta.
 who-DAT/*ACC-COP-QUE not.know-PRES-DECL
 ‘Mimi was scolded by someone, but I don’t know by whom.’
- b. Mimi-nun honna-ss-nuntey, **nwukwu-eykey/*lul-i-nci**
 Mimi-TOP be.scolded-PST-but who-DAT/*ACC-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 ‘Mimi was scolded, but I don’t know by whom.’

island constraints

- The merger type of sluicing in English is insensitive to islands (Ross 1969, Chung et al. 1995, Merchant 2001, 2006, 2012, Fox and Lasnik 2003).
 - (15) a. Bo talked to the people who discovered something, but we don't know what (*Bo talked to the people who discovered __). (Complex Noun Phrase Constraint)
 - b. Terry wrote an article about Lee and a book about someone else from East Texas, but we don't know who (*Terry wrote an article about Lee and a book about __). (Coordination Structure Constraint)
- Meanwhile, sprouting fails to repair syntactic island violations:
 - (16) a. *I saw the movie that showed Ivy eating, but I just can't remember what. (Complex Noun Phrase Constraint)
 - b. *Agnes wondered how John could eat, but it is not clear what. (*Wh*-island Constraint)

island violations in Korean

- Korean merger examples appear to repair islands as seen from the following examples (data from Sohn 2000):

(17) Shally-ka kunye-uy tongsayng-i nwukwunka-lopwuthe cenhwa-lul
 Shally-NOM she-GEN sister-NOM someone-from phone-ACC
 pat-un twiey ttenass-nuntey, na-nun nwukwu-i-nci
 receive-PNE after left-but, I-TOP who-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 'Shally's sister left [after receiving a phone call from someone], but I don't know from whom.'
- Considering sprouting cases in Korean (where the null object is marked as *pro*), we observe that island constraints are hard to repair:

(18) ??/*Mimi-ka *pro* masisskey mek-ess-ten siktang-ul
 Mimi-NOM deliciously eat-PST-PNE restaurant-ACC
 chach-ass-nuntey, (kukey) mwues-i-nci molu-keyss-ta.
 find-PST-but it what-COP-QUE not.know-PRES-DECL
 'I found the restaurant [where Mimi ate (something) deliciously], but we do not know what.'

P-stranding generalization

- Merchant (2001, 2006) observes a strong correlation between the availability of preposition stranding with *wh*-movement and the possibility for sluicing a *wh*-phrase without a preposition:

- (19) a. Peter was talking with someone, but I don't know (with) who.
(Merchant 2006: (9))
- b. Who was he talking with?

- Korean: no preposition stranding language

- (20) a. Mimi-ka nwukwunka-wa nolko-iss-nuntey,
Mimi-NOM someone-with play-PRES-but
nwukwu-(wa)-i-nci molu-keyss-ta.
who-with-COP-QUE not.know-PRES-DECL
'Mimi is playing with someone, but I don't know with whom.'
- b. *nwukwu Mimi-ka -wa nolko-iss-ni?
who Mimi-NOM with play-PRES-QUE
'(int) Whom is Mimi playing with?'

P-stranding generalization

- It is possible to omit the postposition (-*wa*) under embedded sluicing. Note that there is a contrast between merger and sprouting in this respect:

- (21) a. Mimi-ka nwukwunka-lopwuthe senmwul-ul
 Mimi-NOM someone-from present-ACC
 pat-ass-nuntey, nwukwu-(**lopwuthe**)-i-nci
 receive-PST-but who-(from)-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 ‘Mimi received a present from someone, but I do not know from whom.’
- b. Mimi-ka pinan pat-ass-nuntey,
 Mimi-NOM criticism receive-PST-but
nwukwu-(**lopwuthe**)-i-nci molu-keyss-ta.
 who-(from)-COP-QUE not.know-PRES-DECL
 ‘Mimi received a criticism (from someone), but I do not know from whom.’

Sluicing in English: Deletion approach

- assume movement of a *wh*-phrase followed by deletion, as originated with Ross (1969) and developed further by Merchant (2001, 2012), and others.

(22) a. Mary met somebody, but I don't know who.
 b. ..., but I don't know [_{CP} who_i [Mary met t_i]].

- Korean sluicing can be also taken to include a movement of a *wh*-phrase and a deletion process (Kim, J.-S. 1997):

(23) a. Mimi-ka nwukwunka-lul manna-ss-nuntey, na-nun
 Mimi-NOM who-ACC meet-PST-but I-TOP
 nwukwu-i-ess-nunci molu-keyss-ta.
 who-COP-PST-QUE not.know-PRES-DECL
 'Mimi met someone, but I don't know who.'
 b. ..., na-nun [_{FOCP} nwukwu_i-lul [_{TP} [_{VP} Mimi-ka t_i
 manna]-ss]-(nu)nci] molu-keyss-ta.

the copula

- the deletion approach for sluicing in Korean raises an immediate question of why the construction introduces the obligatory copular verb

(24) nwukwu-lul Mimi-ka manna-ss-(*i)-nunci molu-keyss-e.
 who-ACC Mimi-NOM meet-PST-COP-QUE not.know-PRES-DECL
 '(I) do not know who Mimi met.'

- Avoiding the issues of introducing the copula to the sluicing construction in the deletion approach and positing rather complex processes of deletion, some works in literature has taken the pseudocleft as the putative source for Korean sluicing

(25) na-nun [~~Mimi-ka manna-n kes-un~~] nwukwu-i-nci
 I-TOP Mimi-NOM meet-PNE KES-TOP who-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 'I do not know who (Mimi met).'

Issues: discrepancies between pseudoclefting and sluicing

- one clear difference comes from the possibility of multiple remnants in sluicing and the impossibility of multi-pivot clefts

- (26) a. *[John-i ecey cwu-n kes-un] Mimi-eykey
 John-NOM yesterday give-PNE KES-TOP Mimi-DAT
 chayk-i-ta.
 book-COP-DECL
 '(int.) What John gave yesterday is to Mary a book.'
- b. John-i ecey nwukwunka-eykey mwuesinka-lul
 John-NOM yesterday someone-DAT something-ACC
 cwuess-nuntey, nwukwu-eykey mwues-i-nci molukeyssta
 gave-but who-DAT what-COP-QUE not.know
 'John gave something to someone yesterday, I wonder to whom and what.'

Issues: discrepancies between pseudoclefting and sluicing

- there are sluicing examples with no cleft counterpart.

- (27) a. Mimi-ka cha-lul kochoy-ess-nuntey, ettehkey-i-nci
 Mimi-NOM car-ACC fix-PST-but how-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 ‘Mimi fixed the car, but I don’t know how.’
- b. ?*[Mimi-ka cha-lul kochi-n kes-un] ettehkey-i-ci?
 Mimi-NOM car-ACC fix-PNE KES-TOP how-COP-QUE
 ‘(Int.) The thing that Mimi fixed the car is how?’
- c. ?*[Mimi-ka cha-lul kochi-n kes-un] acwu swipkey-i-ta.
 Mimi-NOM car-ACC fix-PNE KES-TOP really easy-COP-DECL
 ‘(Int.) The way Mimi fixed the car is really easy.’

Issues: discrepancies between pseudoclefting and sluicing

- floated numeral classifier also displays another contrast between pseudocleft and sluicing

- (28) a. [Mimi-ka sa-n kes-un] [chayk sey kwen]-i-ta.
 Mimi-NOM buy-PNE KES-TOP [book three CL]-COP-DECL
 ‘What Mimi bought was three books.’
- b. Mimi-ka chayk-ul myech kwen sa-ss-nuntey, na-nun myech
 Mimi-NOM book-ACC some CL buy-PST-but I-TOP how-many
 kwen-i-nci molu-n-ta
 CL-COP-QUE not.know-PRES-DECL
 ‘Mimi bought some books, but I do not know how many.’
- c. *[Mimi-ka chayk-ul sa-n kes-un] sey kwen-i-ta.
 Mimi-NOM book-ACC buy-PNE KES-TOP three CL-COP-DECL
 ‘What Mimi bought books is three (volumes).’

LF copying

- The LF copying approach introduces a null element (or elements) at the ellipsis site in the syntax. This null element is replaced by an operation of structure copying before the structure is interpreted (see Chung et al. 1995, 2010, Lappin 1996, Fortin 2007).

- (29) a. I don't know [_{CP} what [_{IP} e]] (Spell-Out)
 b. I don't know [_{CP} what_i [_{IP} John plays t_i]] (LF copying/interpreted structure)

- Merits:

- (30) a. They are jealous, but it is unclear of whom.
 b. *They are jealous, but it is unclear who.

LF copying derivations

- grammatical cases

- (31) a. It is unclear [_{CP} of whom [_{IP}]] ⇒
 b. It is unclear [_{CP} of whom [_{IP} they are jealous]] ⇒
 c. It is unclear [_{CP} of whom [_{IP} they are jealous [of whom]]].

- no new word constraint:

- (32) a. It is unclear [_{CP} who [_{IP}]] ⇒
 b. It is unclear [_{CP} who [_{IP} they are jealous]] ⇒
 c. It is unclear [_{CP} who [_{IP} they are jealous who]].

LF copying: an issue

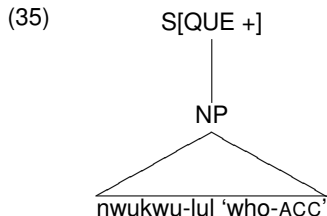
- note that this syntax-based re-use analysis runs into problems for examples requiring semantic identity in both English and Korean.
(33) a. John likes someone, but I don't know who.
b. John likes someone, but I don't know [who [John likes someone]].
- If the antecedent *John likes someone* is re-used, there is a danger for the indefinite *someone* to refer to a different person, as also pointed out by Larson (2013). The re-use analysis would thus do good for examples requiring syntactic identity, but encounters issues with semantic identity.

Direct Interpretation

- generate the meanings of the unpronounced material with no underlying syntactic structures (Ginzburg and Sag 2000, Kehler 2002, Culicover and Jackendoff 2005)

(34) A: Mimi-ka ecey manna-ss-e.
 Mimi-NOM yesterday meet-PST-DECL
 'Mimi met yesterday.'

B: nwukwu-lul?
 who-ACC?



Identity issues

- The elided material must be identical in some way or other to a putative antecedent available in the discourse.
- Two main views: the semantic view (Sag and Hankamer 1984, Ginzburg and Sag 2000, Winkler 2005, Culicover and Jackendoff 2005, Reich 2008, van Craenebroeck 2010, Aelbrecht 2010, among others) and the syntactic view (Sag 1976, Williams 1977, Fiengo and May 1994, Chung et al. 1995, 2010, Kehler 2002, Merchant 2013)
- my claim: both semantic and syntactic identity are required.

semantic identity

- The semantic identity: There is a semantic relation between E (elided clause) and A (antecedent clause) to license sluicing
- Merchant's (2001) mutual entailment relationship between the elided material and its antecedent.

- (36) a. He resembled someone, but I do not know who.
b. Antecedent clause $[[A]] = \exists x(\text{He resembled } x)$
c. Elided clause $[[E]] = \exists x(\text{He resembled } x)$

resolving the syntactic identity issues

- In a variety of authentic examples where there is no overt linguistic antecedent, the semantic identity seems to work well (see Ginzburg and Sag 2000 for similar discussion with English data).
- a dialogue between two bilingual speakers:
(37) A: Mimi-ka nwukwunka-wa ssaw-ess-e?
Mimi-NOM someone-with fight-PST-QUE
'Did Mimi fight with someone?'
B: Yes, but I don't know with whom.

pros for the semantic identity

- dialogue with a deictic expression:

(38) A: nwukwunka-ka na-lul ttalao-ko iss-e.
 someone-NOM me-ACC follow-CONN be-DECL
 ‘Someone is following me.’

 B: nwukwu-i-nci kwungkumha-ney.
 who-COP-QUE wonder-DECL
 ‘I wonder who is following you \neq who is following me.’

- If the antecedent of the *wh*-remnant in B’s response were based on syntactic identity, we would obtain a wrong interpretation here (see Sag and Nykiel 2011 for similar points in English).

syntactic identity in the voice matching

- Unlike VP Ellipsis, sluicing does not tolerate voice mismatches.
- (39) a. The problem was to have been looked into, but obviously nobody did <look into the problem>.
b. I have implemented it with a manager, but it doesn't have to be <implemented with a manager>.
- (40) a. *Someone shot Ben, but I don't know by whom <Ben was shot>.
b. *Someone was shot, but I don't know whom <they shot>.

argument structure matching

- sluicing does not tolerate argument structure mismatches involving raising, ditransitive, and *tough* predicates:
 - (41) a. *Ben believes that someone is insane, but I cannot tell whom
<Ben believes to be insane>.
 - b. ??Ben gave someone the bike, but I cannot tell to whom
<Ben gave the bike>.
 - c. *Someone is impossible for Ben to please, but I don't know
whom <it is impossible for Ben to please>.

voice matching in Korean sluicing

- Korean sluicing also includes examples where syntactic identity is required. For example, sluicing does not tolerate voice mismatches:

- (42) a. *nwukwunka-ka Mimi-lul ttayly-ess-nuntey,
 someone-NOM Mimi-ACC hit-PST-but
 nwukwu-eykey-i-nci molu-keyss-ta.
 who-by-COP-QUE not.know-PRES-DECL
 ‘*Someone hit Mimi, but I don’t know by whom <Mimi was hit>.’
- b. Antecedent clause $[[A]] = \exists x(x \text{ hit Mimi})$
- c. Elided clause $[[E]] = \exists x(\text{Mimi was hit by } x)$

case matching

- if the *wh*-remnant has a semantic case, the case value is optional but must match with that of the correlate if it is realized.

- (43) a. Mimi-nun nwukwunka-eykey phyenci-lul ponay-ss-nuntey,
 Mimi-TOP someone-to letter-ACC send-PST-but
nwukwu-(eykey/*lopwuthe)-i-nci molu-keyss-ta.
 who-(to/*from)-COP-QUE not.know-PRES-DECL
 ‘Mimi sent a letter to someone, but I don’t know to whom.’
- b. kong-i kapcaki etinka-lopwuthe nalao-ass-nuntey,
 ball-NOM suddenly somewhere-from fly-PST-but
eti>(*ey/lopwuthe)-i-nci molu-keyss-ta.
 where>(*to/from)-COP-QUE not.know-PRES-DECL
 ‘(lit.) A ball suddenly flew in from somewhere, but I don’t know from where.’

Requirements on the semantic case matching in sprouting

- Unlike merger examples, sprouting requires the presence of a semantic case on the *wh*-remnant matching with the case value of the covert correlate:

- (44) a. pise-ka hwa-lul nay-ss-nuntey,
 secretary-NOM anger-ACC raise-PST-but
nwukwu-*(eykey)-i-nci molu-keyss-ta.
 who-DAT-COP-QUE not.know-PRES-DECL
 ‘The secretary got angry, but I don’t know at whom.’
- b. cek-i hwutoy-lul ha-yess-nuntey, **eti-*(kkaci)**-i-nci
 enemy-NOM retreat-ACC do-PST-but where-to-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 ‘The enemy retreated, but I do not know up to where.’

Construction Grammar

- In accounting for the grammatical properties of the sluicing construction, we accept the philosophy of Construction-based HPSG.
- Within the philosophy of Construction Grammar (CxG), all levels of description (including morpheme, word, phrase, and clause) are understood to involve pairings of form with semantic or discourse functions, and grammar is a recursive system of constructions

$$(45) \quad \left[\begin{array}{l} \textit{construction} \\ \text{FORM [...]} \\ \text{SYN [...]} \\ \text{SEM [...]} \\ \text{CXT [...]} \end{array} \right] \rightarrow \left[\begin{array}{l} \textit{construction} \\ \text{FORM [...]} \\ \text{SYN [...]} \\ \text{SEM [...]} \\ \text{CXT [...]} \end{array} \right] \dots \left[\begin{array}{l} \textit{construction} \\ \text{FORM [...]} \\ \text{SYN [...]} \\ \text{SEM [...]} \\ \text{CXT [...]} \end{array} \right]$$

examples of the constructions

- Constructions also vary in size and complexity, and form and function are specified if not readily transparent.

Constructions	Examples
Morpheme	<i>pre-, -ing</i>
Word	<i>avocado, anaconda, and</i>
Complex word	<i>daredevil, shoo-in</i>
Complex word (partially filled)	[N-s] (for regular plurals)
Idiom (filled)	<i>going great guns, give the Devil his due</i>
Idiom (partially filled)	<i>jog (someone's) memory, send (someone) to the</i>
Covariational conditional	The X-er the Y-er (<i>The more you have, the better</i>
Ditransitive	Subj V Obj1 Obj2 (<i>He gave her a fish taco.</i>)
Passive	Subj Aux VP (PP[by]) (<i>The armadillo was hit by a</i>

Table: Examples of constructions, varying in size and complexity (Goldberg 2006)

Representing interrogative expressions

- the *wh*-phrase: represents a parameter consisting of an index and a set of restricting propositions for what the referent of the parameter refers to:

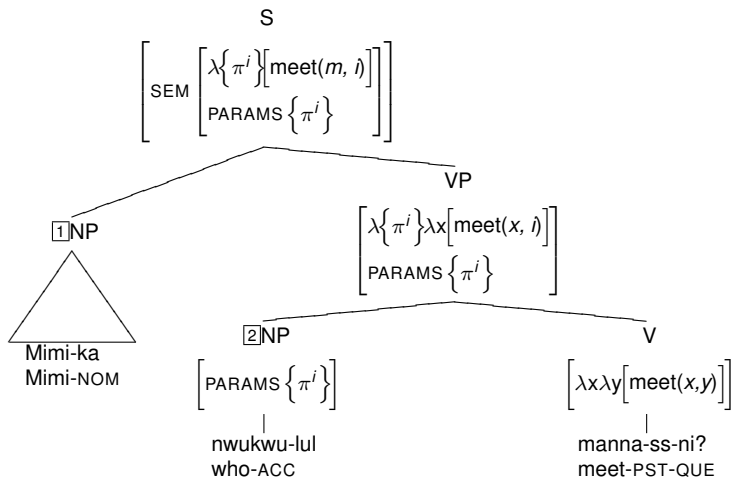
(46) Semantic content of *who*: $\pi^i \{\text{person}(i)\}$

- semantic representation for interrogatives

- (47) a. Polar question: $\lambda\{\ \} [\text{love}(k, l)]$ (Does Kim love Lee?)
 b. Unary *wh*-question: $\lambda\{\pi^i\} [\text{love}(k, \hat{l})]$ (Who does Kim love?)
 c. Multiple *wh*-question: $\lambda\{\pi^i \pi^j\} [\text{love}(i, j)]$ (Who loves who?)

semantic composition of a wh-question

(48)



Dialogue and Question Under discussion

- The interpretation of a sluiced clause depends on the notion of 'question-under-discussion (QUD)' in the dialogue.
- Dialogues are described via a Dialogue Game Board (DGB) where the contextual parameters are anchored and where there is a record of who said what to whom, and what/who they were referring to (see Ginzburg 1996, Ginzburg and Fernandex 2010).
- DGB monitors which questions are under discussion, what answers have been provided by whom, etc. The conversational events are tracked by various conversational 'moves' that have specific preconditions and effects.

Main claim

- The main claim: non-sentential utterances are resolved to the contextual parameters of the DGB.
- Since the value of QUD is constantly being updated as a dialogue progress, the relevant context offers the basis of the interpretation for sluicing.
- Interpreting this system in terms of the feature-structure based system: The feature MAX-QUD, representing the question currently under discussion, takes as its value *questions*. Meanwhile, SAL-UTT, taking as its value syntactic as well as semantic information, represents the utterance which receives the widest scope within MAX-QUD.

$$(49) \quad \left[\text{DGB} \left[\begin{array}{l} \text{SAL-UTT ...} \\ \text{MAX-QUD ...} \end{array} \right] \right]$$

An example

- Uttering the question *Who did Kim meet?* will activate the following feature structure with the appropriate DGB information:

$$(50) \left[\begin{array}{l} \text{FORM} \langle \text{Who did Kim meet?} \rangle \\ \text{SYN S} \\ \text{SEM } \lambda \{ \pi^i \} [\text{meet}(k, i)] \\ \text{DGB} \left[\begin{array}{l} \text{MAX-QUD } \lambda \{ \pi^i \} [\text{meet}(k, i)] \\ \text{SAL-UTT} \left[\begin{array}{l} \text{SYN NP} \\ \text{SEM } \pi^i \end{array} \right] \end{array} \right] \end{array} \right]$$

Constraint for resolved questions

- One important constraint working here is that resolved questions cannot be under discussion (Ginzburg and Sag 2000, Sag and Nykiel 2011):

(51) Question Introduction Condition (QIC)

A question q can be introduced into QUD by A only if there does not exist a fact τ such that $\tau \in \text{FACTS}$ and τ resolves q .

- an indefinite NP as well as a definite or quantified NP can function as a correlate as long as it can accommodate a compatible MAX-QUD environment.

- (52) a. Indefinite NP: **Some senator** is arriving. Who?
 b. Quantified NP: I talked to **most of the players**. Oh yeah, who, exactly?
 c. Definite NP: **The tallest guy of the team** is here. Who else?
 d. Proper Noun: I met **Kim**. Who else?
 e. Pronoun: **She** came to the party. Who else?

But block the following

- However, note the following: the question of who arrived or who will visit Pat is no longer under discussion.
(53) a. **No one** arrived. *Who?
b. **Kim** arrived. *Who?
c. **Kim and Lee** will visit Pat. *Who?

Korean examples

- the QIC also holds in the typologically different language, Korean.

- (54) a. Mimi-lul manna-ss-e. kupakkey nwukwu?
 Mimi-ACC meet-PST-DECL else who?
 '(I) met Mimi. Who else?'
- b. *amwuto an o-ss-e. nwukwu?
 nobody not come-PST-DECL who
 'Nobody came. *Who?'

fragments

- Korean has a variety of fragment utterances including short answers.

(55) A: Kim-i yeki-ey iss-ni?
 Kim-NOM here-at exist-QUE
 'Is Kim here?'

B: iss-e. / eps-e.
 exist-DECL. / not.exist-DECL
 '(He) is.' '(He) isn't.'

- The language also allows nominal fragments as short answers:

(56) A: Kim-i nwukwu-lul manna-ss-ni?
 Kim-NOM who-ACC meet-PST-QUE
 'Who did Kim meet?'

B: Mimi. / Mimi-lul. / *Mimi-ka.
 Mimi / Mimi-ACC / Mimi-NOM

case connectivity in fragment answers

- The short answer fragment can be an interrogative *wh*-expression (which we call matrix sluicing), similar to English sluicing.

(57) A: Mimi-ka nwukwunka-lul manna-ss-e.
 Mimi-NOM someone-ACC meet-PST-DECL
 'Mimi met someone.'

B: nwukwu? / nwukwu-lul? / *nwukwu-ka?
 who? who-ACC? who-NOM

Head Fragment Construction

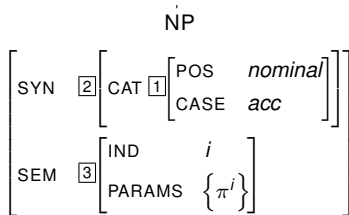
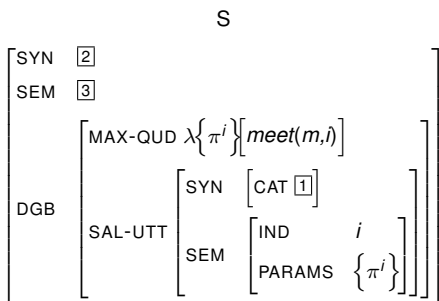
- The interpretation of a matrix sluicing fragment, a non-sentential utterance, also depends on the notion of QUD in the given context.
- As suggested by Kim and Sells (2013a, 2013b), we first introduce the following construction for Korean, similar to English (Ginzburg and Sag 2000):

(58) Head-Fragment Construction

$$\left[\begin{array}{c} \text{SYN} \quad \text{S} \\ \text{DGB} \left[\begin{array}{c} \text{SAL-UTT} \left[\begin{array}{c} \text{SYN} \quad [\text{CAT} \quad \boxed{1}[\textit{nominal}]] \\ \text{SEM} \quad [\text{IND} \quad i] \end{array} \right] \end{array} \right] \end{array} \right] \rightarrow \left[\begin{array}{c} \text{SYN} \quad [\text{CAT} \quad \boxed{1}[\textit{nominal}]] \\ \text{SEM} \quad [\text{IND} \quad i] \end{array} \right]$$

a projected structure

(59)



nwukwu-lul 'who-ACC'?

Case Omission

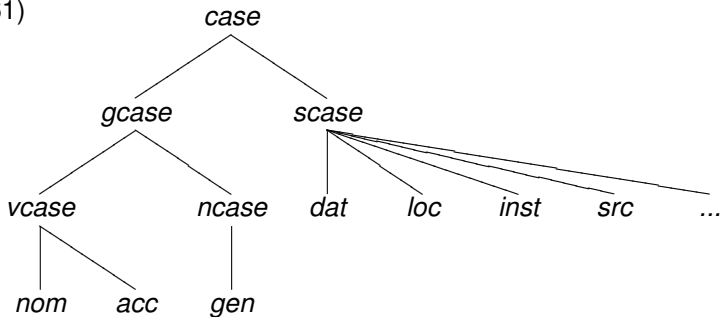
- Why is the bare case marking NP *nwukwu* possible?
- In Korean, different from semantic cases (*scase*), the structural or grammatical case (*gcase*) values can be optional, as illustrated in the following contrast:

- (60) a. Mimi-(ka) Mina-(lul) manna-ss-e.
 Mimi-NOM Mina-ACC meet-PST-DECL
 'Mimi met Mina.'
- b. Mimi-(ka) Mina-*(wa) nol-ko iss-e.
 Mimi-NOM Mina-with play-CONN exist-DECL
 'Mimi is playing with Mina.'

Bare case-marking Fragment Answers

- Assumes the case system in Korean in which the unmarked case value subsumes the structural case values (NOM and ACC) (see Kim, J.-B. 2004 and Kim and Choi 2004).

(61)



Sample lexical entries

- (62) a.
$$\left[\begin{array}{l} \text{FORM } \langle \textit{nwukwunka-lul} \rangle \\ \text{SYN} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{POS} \quad \textit{nominal} \\ \text{GCASE} \quad \textit{acc} \end{array} \right] \end{array} \right] \end{array} \right]$$
- b.
$$\left[\begin{array}{l} \text{FORM } \langle \textit{nwukwu} \rangle \\ \text{SYN} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \text{POS} \quad \textit{nominal} \\ \text{GCASE} \quad \textit{gcase} \end{array} \right] \end{array} \right] \end{array} \right]$$

Bare-case marked fragments with an overt correlate

- with an overt correlate, the *wh*-remnant or fragment answer can be bare-case marked even when the correlate is semantic-case marked. This is possible since there is also no conflict in the case features.

- (63) A: Mimi-ka nwukwunka-lopwuthe senmwul-ul
 Mimi-NOM someone-SRC gift-ACC
 pat-ass-e.
 receive-PST-DECL
 'Mimi received a gift from someone.'
- B: nwukwu?/ nwukwu-lopwuthe?/ nwukwu-eykey?/
 who who-SRC who-SRC
 *nwukwu-wa?
 who-COMIT
 'Who?/From whom? /To whom? /*With whom?'

case feature information

(64) a.
$$\left[\begin{array}{l} \text{FORM} \langle \textit{nwukwunka-lopwuthe} \rangle \\ \text{SYN} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{ll} \text{POS} & \textit{nominal} \\ \text{GCASE} & \textit{gcase} \\ \text{SCASE} & \textit{src} \end{array} \right] \end{array} \right] \end{array} \right]$$

b.
$$\left[\begin{array}{l} \text{FORM} \langle \textit{nwukwu} \rangle \\ \text{SYN} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{ll} \text{POS} & \textit{nominal} \\ \text{GCASE} & \textit{gcase} \\ \text{SCASE} & \textit{scase} \end{array} \right] \end{array} \right] \end{array} \right]$$

sprouting with no overt correlate

- Consider the examples again? Why no bare-case marked?

(65) A: Mimi-ka pinan.pat-ass-e.
Mimi-NOM criticism.receive-PST-DECL
'Mimi was criticized.'
B: nwukwu-lopwuthe?/*nwukwu?
who-from/who

context updating analysis

- Ruppenhofer and Michaelis (2014) distinguish two major types of null complements in English, definite and indefinite null complements:

(66) a. John loves to read [e].
b. No doubt, mistakes were made [e].
c. We arrived [e] at 8 pm.
- The unexpressed argument in (66a) and the one in (66b) behave alike in that the material that John loves to read or the agent making the mistake need not be mutually known to the interlocutors, whose omission can thus be said to be an instance of **indefinite null instantiation (INI)**.
- By contrast, the unexpressed goal argument in (66c) is known to the interlocutors in the given context and the omission of the argument is thus an instance of **definite null instantiation (DNI)**.

Within the feature structure system

- Incorporating this idea within the type feature system (where types are in italics), we can introduce two signs *overt* and *ini*, the latter of which can be resolved to a covert argument or an instance of INI.

(67) Lexical entry for *read*:

$$\left[\begin{array}{l} \text{FORM } \langle \textit{read} \rangle \\ \text{ARG-ST } \langle \text{NP}_i \text{ NP}_x \rangle \\ \text{SYN } \left[\begin{array}{l} \text{SUBJ } \langle \text{NP}[\textit{overt}] \rangle \\ \text{COMPS } \langle \text{NP}[\textit{ini}] \rangle \end{array} \right] \\ \text{SEM } \textit{read}(i, x) \end{array} \right]$$

null arguments in Korean

- null arguments in Korean

- (68) a. [e] cham cal talli-n-ta.
 really fast run-PRES-DECL
 ‘(I/He/She/They/It) really runs fast.’
- b. Mimi-nun Nana-ka [e/*caki/ku-lul*] ttayly-ess-ta-ko
 Mimi-TOP Nana-NOM e/self/he-ACC hit-PST-DECL-COMP
 malha-yess-ta.
 say-PST-DECL
 ‘Mimi said that Nana hit herself/him.’

- The null subject in (68a) refers to someone physically present, whose reference is provided in the discourse context. Meanwhile, the null object in (68b) is in variation with the overt resumptive pronouns, *caki-lul* ‘self-ACC’ or *ku-lul* ‘he-ACC’. Its coindexing relation is controlled (A-bound) by the matrix argument, suggesting it is a *pro*, but not a variable.

null arguments in sprouting

- Sprouting examples we discuss here all include INI cases as evidenced from the fact that we cannot replace the implicit argument by a definite NP:

- (69) a. ches khisu-lul (*ku-wa) ha-yess-nuntey, **nwukwu-wa-i-nci**
 first kiss-ACC he-with do-PST-but who-with-COP-QUE
 molu-keyyss-ta.
 not.know-PRES-DECL
 ‘*(I) did the first kiss with him, but I don’t know with whom.’
- b. Mimi-ka (*ku-lopwuthe) pinan.pat-ass-nuntey,
 Mimi-NOM he-from criticism.receive-PST-but
nwukwu-*(lopwuthe)-i-nci molu-keyyss-ta.
 who-(from)-COP-QUE not.know-PRES-DECL
 ‘Mimi received a criticism from him, but I do not know from whom.’

lexical information

- The unrealized argument of the matrix verb *pinan.pat-* ‘be criticized’ in (65A) and the one in (69b), both of which are sprouting examples, is realized not as a definite but as an indefinite instantiation, as represented in the following:

(70) Lexical information for *pinan.pat-* ‘be.criticized’

FORM	$\langle \textit{pinan.pat-} \rangle$				
ARG-ST	$\langle \text{NP}_i, \text{NP}_x[\text{SCASE } \textit{src}] \rangle$				
SYN	<table style="border-collapse: collapse; margin-left: 20px;"> <tr> <td style="border-right: 1px solid black; padding: 5px;">SUBJ</td> <td style="padding: 5px;">$\langle \text{NP}[\textit{overt}] \rangle$</td> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">COMPS</td> <td style="padding: 5px;">$\langle \text{NP}[\textit{ini}] \rangle$</td> </tr> </table>	SUBJ	$\langle \text{NP}[\textit{overt}] \rangle$	COMPS	$\langle \text{NP}[\textit{ini}] \rangle$
SUBJ	$\langle \text{NP}[\textit{overt}] \rangle$				
COMPS	$\langle \text{NP}[\textit{ini}] \rangle$				
SEM	$\textit{be.criticized}(i, x)$				

an example

- Now consider the dialogue in (65).

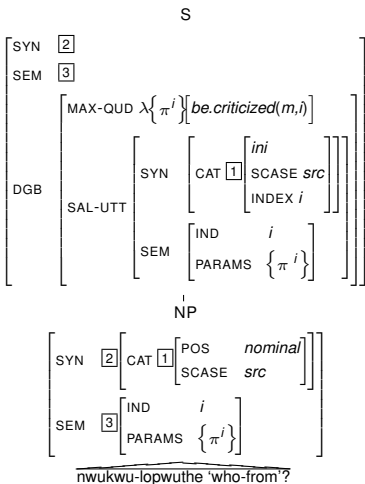
(65) A: Mimi-ka pinan.pat-ass-e.
 Mimi-NOM criticism.receive-PST-DECL
 'Mimi was criticized.'
 B: nwukwu-lopwuthe?/*nwukwu?
 who-from/who

- Uttering the sentence with A would then update the DGB as following, triggered from the verb *pinan.pat*- 'be criticized':

(71)
$$\left[\text{DGB} \left[\text{SAT-UTT} \left[\text{SYN NP} \left[\begin{array}{l} \textit{ini} \\ \text{SCASE } \textit{src} \\ \text{INDEX } \textit{x} \end{array} \right] \right] \right] \right] \left[\text{SEM } \textit{be.criticized}(m,x) \right]$$

Projected structure

(72)



A remaining question

- Why the bare-case marked NP is not licensed with the absence of an overt correlate (see (65))?
- The case marker of the covert or unexpressed NP whose syntactic information is contextually updated must be present. This condition can be phrased as following:

(73) Full Instantiation Constraint (FIC):
The syntactic information (e.g., case features) not available at surface but updated in the DGB needs to be fully specified in the subsequent syntax.

- This condition has the effect of Chung's (2006) 'no new word constraint' specifying that an ellipsis site cannot contain any 'new' words

Motivation

- The motivations of the FIC can be found in the anaphoric nature of sluicing and the question of identifying what is an issue (question under the discussion).
- With the merger case with an overt correlate, we have no difficulties in identifying this issue. However, sprouting examples with no overt correlate make it difficult to pick out the issue:

- (74) a. [The cake was eaten by someone], and I want to find out [who] <the cake was eaten by>.
- b. *[The cake was eaten], and I want to find out [who] <ate the cake>.

Fragment answer again

- consider the following dialogue in Korean:

(75) A: John-i ecey pam salhaytoy-ess-e.
 John-NOM yesterday night be.murdered-PST-DECL
 'John was murdered last night.'
 B: nwukwu-eyuyhay? / *nwukwu?
 who-by / who
 'By whom?'

- The FIC: the syntactic information of the unrealized agentive NP be specified at the subsequent syntax, linking the contextually updated information with syntax (or morphosyntactic) information.

(76)
$$\left[\text{DGB} \left[\text{SAT-UTT} \left[\text{SYN NP} \left[\begin{array}{l} \textit{ini} \\ \text{SCASE } \textit{agt} \\ \text{INDEX } x \end{array} \right] \right] \left[\text{SEM } \textit{be.murdered}(j,x) \right] \right] \right]$$

FIC for sprouting

- When there is no correlate for the *wh*-remnant, and its correlate is evoked at the discourse level, the grammar needs to refer to the full grammatical information of the evoked correlate to minimize the processing load.

(77) A: han haksayng-i senmwul-ul pat-ass-e.
 a student-NOM present-ACC receive-PST-DECL
 ‘A student received a present.’
 B: nwukwu-lopwuthe?/nwukwu?
 who-SRC/who?
 ‘From Whom?/Who?’

- The case-marked NP *nwukwu-lopwuthe* ‘who-SRC’ is asking from whom the student received a present, while the bare-case marked NP *nwukwu* ‘who’ is linked to the indefinite NP subject *a student*.

matrix vs. embedded sluicing

- The embedded sluicing, merger and sprouting alike, can license the optional subject *kukey* 'it' here, but this is not possible in matrix (short answer) fragments.

(78) Mimi-ka pinan.pat-ass-nuntey, kukey nwukwu-lopwuthe-i-nci
 Mimi-NOM criticism.receive-PST-but it who-from-COP-QUE
 molu-keyss-ta.
 not.know-PRES-DECL
 'Mimi received a criticism, but I do not know from whom it is.'

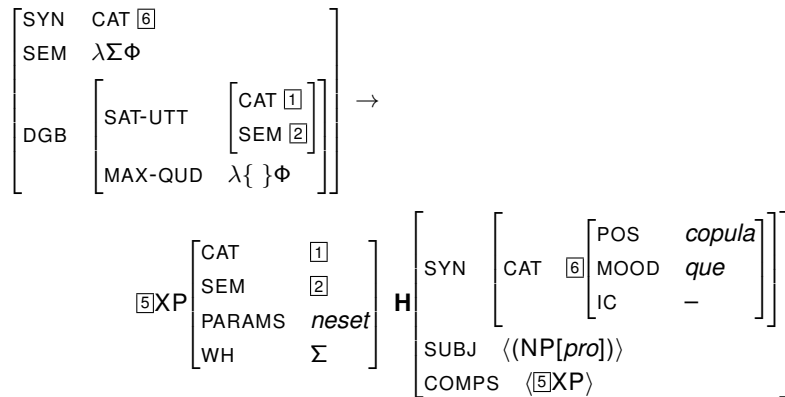
(79) A: Mimi-ka pinan.pat-ass-e.
 Mimi-NOM criticism.receive-PST-DECL
 'Mimi was criticized.'
 B: *kukey nwukwu-lopwuthe?
 it who-from?

- Fragment answers and sluicing are different

Sluicing constructions in Korean

- matrix sluicing in Korean is a nominal fragment while embedded sluicing is a predicate fragment.

(80) Embedded Sluicing Construction in Korean:



Going back to embedded sluicing

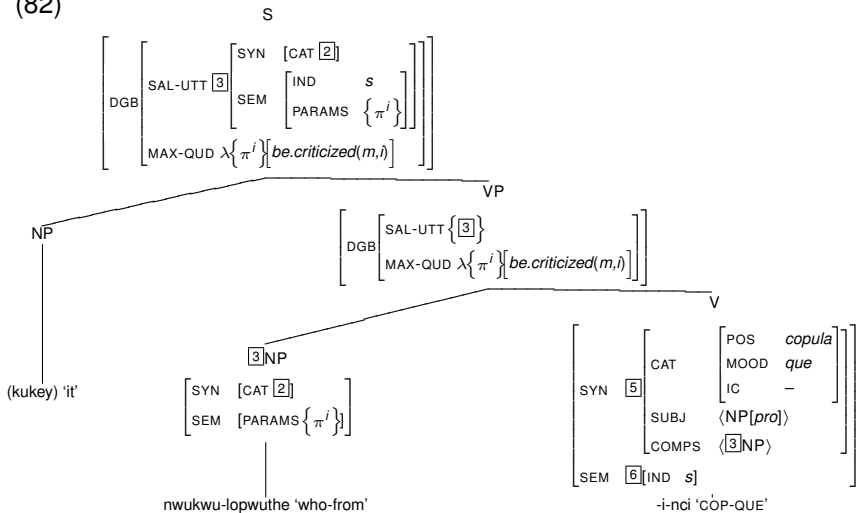
- merger and sprouting: the two types behave differently with respect to the realization of case markings. In particular, with no overt correlate, the *wh*-remnant must have the case value corresponding to that of the covert correlate.

(81) A: Mimi-ka pinan.pat-ko iss-e.
 Mimi-NOM be.criticized-CONN exist-DECL
 'Mimi is being criticized.'

B: (kukey) **nwukwu-lopwuthe**-i-nci al-ni?
 it who-from-COP-QUE know-QUE
 'Do you know from whom?'

an example

(82)



reverse sluicing

- The present system thus relies on the discourse update, implying that the precedence relationship with the clause including a correlate is not a key issue.

(83) a. *nwukwu-i-nci molu-ciman, nwukwun-ka nay cha-lul*
 who-COP-QUE not.know-but someone-NOM my car-ACC
 kocangnay-ss-e.
 break-PST-DECL

‘I don’t know who, but someone broke my car.’

b. *way-i-nci molu-ciman, Mimi-ka ttena-ss-e.*
 why-COP-QUE not.know-but Mimi-NOM leave-PST-DECL
 ‘I don’t know why, but Mimi left.’

- Until meeting the second clause in each of these examples, there is no information about the QUD. The overt indefinite *nwukwun-ka* of the matrix clause in (83a) and the covert indefinite correlate of the matrix clause in (83b) helps to evoke the appropriate QUD for each case.

indexical resolution: semantic identity

- the value of MAX-QUD is constantly being updated as a dialogue progresses, including the record of the denotation of any given referring expression.

(84) A: nwukwunka-ka na-lul ttalao-ko iss-e.
 someone-NOM me-ACC follow-CONN be-DECL
 ‘Someone is following me.’

 B: nwukwu-i-nci kwungkumha-ney.
 who-COP-QUE wonder-DECL
 ‘I wonder who is following you \neq who is following me.’

- A’s utterance here would evoke the following DGB:

(85) $\left[\begin{array}{l} \text{DGB} \left[\begin{array}{l} \text{MAX-QUD } \lambda \{ \pi^i \} \left[\text{follow}(i, \text{spk}) \right] \\ \text{SAL-UTT} \left[\begin{array}{l} \text{SYN NP} \\ \text{SEM } \textit{someone}^i \end{array} \right] \end{array} \right] \end{array} \right]$

island repair

- Island repair for merger type of sluicing has been an issue for the deletion approach that involves the application of *wh*-movement: the movement cannot violate island constraints, but sluicing examples license island repair.
- As a solution, the deletion approach has suggested that the deletion and movement processes in sluicing are relevant to PF representations (see Merchant 2001, 2004 and subsequent papers).
- By contrast, our DI approach, following Ginzburg and Sag (2000), Culicover and Jackendoff (2005), and Sag and Nykiel (2011), avoids this issue: the remnants are directly generated, and no island-sensitive operations are thus involved.

remaining question

- A question arises why island repair in sprouting is in general more difficult to be repaired than island repair in merger

(86) *I saw the movie that showed Ivy eating, but I just can't remember what.

- This sentence, including no overt correlate for the *wh*-remnant, would update the following DGB, triggered by the lexical expression *eating*:

(87)
$$\left[\text{DGB} \left[\text{SAT-UTT} \left[\begin{array}{l} \text{SYN NP} \left[\begin{array}{l} \textit{ini} \\ \text{INDEX } x \end{array} \right] \\ \text{SEM } \textit{eat}(i,x) \end{array} \right] \right] \right] \right]$$

- The second argument of the verb *eat* is realized as an *ini* argument. The FIC in (73) requires that the syntactic information of the INI NP is fully specified since the correlate's information is not available at surface.

If we specify the syntactic information of this NP, we can easily notice that the NP is positioned within the complex NP, violating the CNPC requiring that no syntactic operation should refer to an expression within the island.

connectivity effects

- The CASE compatibility requirement can also account for the voice matching effect in sluicing.
 - (88) a. *Someone shot Ben, but I don't know by whom <Ben was shot>.
 - b. *nwukwunka-ka Mimi-lul sso-ass-nuntey, na-nun
 someone-NOM Mimi-ACC shoot-PST-but I-TOP
nwukwu-eykey-i-nci molu-keyss-ta.
 who-by-COP-QUE not.know-PRES-DECL
 ‘*Someone shot Mimi, I don't know by whom.’
 - (89) a. *The criminal was caught, but I do not know who <caught the criminal>.
 - b. ku pemin-i cap-hi-yess-nuntey,
 the criminal-NOM catch-PASS-PST-but
nwukwu-*(eykey)-i-nci molu-keyss-ta.
 who-by-COP-QUE not.know-PRES-DECL
 ‘The criminal was caught, but I do not know by whom.’

Activated DGB

- The first clause in (88b) here will activate the following DGB:

$$(90) \quad \left[\text{DGB} \left[\begin{array}{l} \text{MAX-QUD } \lambda \{ \pi^i \} [\textit{shoot}(i, m)] \\ \text{SAL-UTT} \left[\begin{array}{l} \text{SYN NP} \\ \text{SEM } \textit{someone}^i \end{array} \right] \end{array} \right] \right]$$

- Since the context here provides the overt correlate *nwukwunka-ka* ‘someone-NOM’, but the *wh*-remnant is *nwukwu-eykey* ‘who-DAT’. The two thus cannot be linked because the Embedded Sluicing Construction requires the two to have the same CAT value including CASE. This is why the *wh*-remnant here cannot be either *nwukwu-eykey* ‘who-DAT’ or *nwukwu-lul* ‘who-ACC’.

sprouting in (89b)

- The matrix predicate in the first clause would have the following lexical information:

(91) Lexical information for *be.caught*-

$$\left[\begin{array}{l} \text{FORM } \langle \textit{be.caught} \rangle \\ \text{ARG-ST } \langle \text{NP}_i; \text{NP}_X[\text{SCASE } \textit{obl}] \rangle \\ \text{SYN } \left[\begin{array}{l} \text{SUBJ } \langle \text{NP}[\textit{overf}] \rangle \\ \text{COMPS } \langle \text{NP}[\textit{ini}] \rangle \end{array} \right] \\ \text{SEM } \textit{be.caught}(c, i) \end{array} \right]$$

- The sentence in (89b) with the *wh*-remnant in the second clause would then update the DGB as following:

(92)

$$\left[\begin{array}{l} \text{DGB} \left[\begin{array}{l} \text{SAT-UTT } \left[\begin{array}{l} \text{SYN NP } \left[\begin{array}{l} \textit{ini} \\ \text{SCASE } \textit{obl} \end{array} \right] \\ \text{SEN } \textit{someone}^i \end{array} \right] \\ \text{MAX-QUD } \lambda \left\{ \pi^i \right\} [\textit{be.caught}(c, i)] \end{array} \right] \end{array} \right]$$

Conclusion

- Both matrix and embedded sluicing, each as a subtype of fragments, is basically an anaphoric phenomenon whose remnant constituents are directly generated without extraction and deletion.
- The present analysis has shown that the QUD in the dialogue provides the basis for the interpretation of the fragments (including matrix sluicing) and sluices in embedded environments.
- Even though the analysis offers a discourse-based account of sluicing with constantly evolving questions-under discussion, it requires syntactic and semantic identity conditions when in need.
- Even with no postulation of hidden syntactic structures, we can offer a satisfactory account for intriguing properties of the sluicing in matrix and embedded environments.

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