Numeral *Any*: in Favor of Viability

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**NELS 51**
UQAM— November 6, 2020
Preview
1. A contrast: *any* vs. ‘numeral *any*’ (Dayal, 2004, 2013)

2. Two analyses:
   - the Wide Scope Constraint Analysis (Chierchia, 2013)
   - the Viability Constraint Analysis (Dayal, 2013)

3. The behavior of collective predicates favours the VCA.
Any vs. ‘Numeral Any’
(1) *Bill read any book.

(2) Bill can read any book.

(3) *Bill must read any book.

(Dayal, 2004, 2013)
Any vs. ‘Numeral Any’ (Dayal, 2004, 2013)

(1) *Bill read any book. (4) *Bill read any two books.
(2) Bill can read any book. (5) Bill can read any two books.
(3) *Bill must read any book. (6) Bill must read any two books.
Any vs. ‘Numeral Any’

(5) Bill can read any two books.

(6) Bill must read any two books.

• (5) conveys universal permission over groupings of two books.
• (6) also conveys universal permission over groupings of two books + existential requirement
Two Analyses
The Wide Scope Constraint (WSC) Analysis (Chierchia, 2013)

The Viability Constraint (VC) Analysis (Dayal, 2013)
Wide Scope Contraint Analysis
Any is an existential that introduces alternatives used by EXH.

(7) \([ \lambda_1 \text{ book}_\mathbb{D} \lambda_1 \text{ Bill read } t_1 ] = R(a) \lor R(b)\)

(scalar alternative)

\{ R(a) \land R(b) \}

(domain alternatives)

\{ R(a), R(b) \}

(pre-exhaustified domain alternatives)

\{ \begin{align*} R(a) \land \neg R(b), \\ R(b) \land \neg R(a) \end{align*} \}
In episodic sentences, strengthening *any* yields a contradiction.

\[(8) \quad \text{[EXH any book}_D \lambda_1 \text{ Bill read } t_1] = \]
\[
[R(a) \lor R(b)] \land [R(a) \leftrightarrow R(b)] \land \neg[R(a) \land R(b)] \iff \bot
\]

\(\exists + \) domain implicature

Scalar component

(negated scalar alternative) \(\neg[R(a) \land R(b)]\)

(negated pre-exhaustified domain alternatives) \([R(a) \leftrightarrow R(b)]\)
Any must scope over modals, also deriving a contradiction.

(9) \[ \text{EXH any book}_D \lambda_1 \text{ can}_C \text{ Bill read } t_1 \] = 
[\(\Diamond_C R(a) \land \Diamond_C R(b)\) \land \neg[\(\Diamond_C R(a) \land \Diamond_C R(b)\)] \Leftrightarrow \bot

(10) \[ \text{EXH any book}_D \lambda_1 \text{ must}_C \text{ Bill read } t_1 \] = 
[\(\Box_C R(a) \land \Box_C R(b)\) \land \neg[\(\Box_C R(a) \land \Box_C R(b)\)] \Leftrightarrow \bot
To avoid the contradiction, one of the conjuncts (i.e. the scalar component) is weakened by requiring its modal domain to be a subset of the original domain.

(‘The Modal Containment Constraint’)

\[(11) \quad [\text{EXH any book}_D \lambda_1 \text{ can}_C \text{ Bill read } t_1] = \]
\[\left[ \Diamond_C R(a) \land \Diamond_C R(b) \right] \land \neg \left[ \Diamond_{C' \subset C} R(a) \land \Diamond_{C' \subset C} R(b) \right] \]
\[\exists + \text{ domain implicature} \quad \text{Scalar component}\]

\[
\begin{array}{c|c}
 w_1 & R(a) \land \neg R(b) \\
 w_2 & \neg R(a) \land R(b)
\end{array}
\]
Modal Containment does not prevent $\perp$ with $\Box$.

- The first conjunct below will contradict any possible weakening of the second conjunct.

\[
\begin{align*}
\exists \text{EXH any book}_D \quad & \lambda_1 \text{ must}_C \text{ Bill read } t_1 \] = \\
[\Box_C R(a) \land \Box_C R(b)] \land \neg[\Box_{C'} \subset C R(a) \land \Box_{C'} \subset C R(b)] \iff \perp
\end{align*}
\]
Numeral *any* also yields $\bot$ in episodic sentences and with $\Box$.

(13) $\left[ \exists X_2 \text{ any two books}_D \lambda_1 \text{ must}_C \text{ Bill read } t_1 \right] = \\
\left[ \Box_C R(a \oplus b) \land \Box_C R(b \oplus c) \land \Box_C R(a \oplus c) \right] \land \neg \Box_C R(a \oplus b \oplus c)$

(14) $\left[ \Box_C R(a \oplus b) \land \Box_C R(b \oplus c) \right] \Rightarrow \Box_C R(a \oplus b \oplus c)$
The Wide Scope Constraint (WSC) Analysis

(Chierchia, 2013)

• Chierchia introduces a constraint called the **Scale Economy Constraint** (SEC)
  • SEC blocks the wide scope constraint as the numeral becomes redundant: the meaning of any sentence containing a numeral reduces to universal quantification
∃ component + domain implicature is equivalent to (16).

(15)  
\[ \left[ \text{EXH any two books}_D \lambda_1 \text{ must}_C \text{ Bill read } t_1 \right] = \]
\[ \left[ \square_C R(a \oplus b) \land \square_C R(b \oplus c) \land \square_C R(a \oplus c) \right] \land \neg \square_C R(a \oplus b \oplus c) \]
\[ \exists + \text{ domain implicature} \]

(16)  
\[ \square_C R(a) \land \square_C R(b) \land \square_C R(c) \]

• First conjunct in (15) \(\Rightarrow\) (16) since ’read’ is a distributive predicate.

• (16) \(\Rightarrow\) first conjunct in (15) due to the cumulativity of the predicate and the universal modal.
The Wide Scope Constraint (WSC) Analysis

(Chierchia, 2013)

No contradiction or violation of the Scale Economy Constraint if numeral *any* scopes under □.

(17) \[
[\lambda_1 \text{EXH must any two books } R(a \oplus b) \text{ Bill read } t_1] =
[\Box[ R(a \oplus b) \lor R(b \oplus c) \lor R(a \oplus c)]] \land
\neg \Box_c[ R(a \oplus b) \lor R(b \oplus c)] \land
\neg \Box_c[ R(a \oplus b) \lor R(a \oplus c)] \land
\neg \Box_c[ R(a \oplus c) \lor R(b \oplus c)]
\]

\[
\begin{array}{|c|c|}
\hline
w_1 & R(a \oplus b) \land \neg R(b \oplus c) \land \neg R(a \oplus c) \\
\hline
w_2 & R(b \oplus c) \land \neg R(a \oplus b) \land \neg R(a \oplus c) \\
\hline
w_3 & R(a \oplus c) \land \neg R(a \oplus b) \land \neg R(b \oplus c) \\
\hline
\end{array}
\]
• *Any* is also existential quantifier that introduces pre-exhaustified domain alternatives.
• The *Viability Constraint* serves to regulate the licensing of *any* by considering the satisfiability of the PDAs across the modal base.
In episodic sentences and when *any* scopes under a modal, *Viability* requires all PDAs to be true in the same world.

\[ \forall \] *Viability* fails in these cases since the alternatives are mutually exclusive.

When *any* outscopes the modal, *Viability* requires that every PDA be satisfiable in some subdomain of the modal.

\[ \forall \] Can be done with possibility modals, but not with necessity modals.
When *any* > □, Viability fails:

strengthening (18) conveys (19), which entails that all PDAs are false in all $C' \subset C$.

(18) any book$_D \lambda_1$ must$_C$ Bill read $t_1$

(19) $\square_C R(a) \land \square_C R(b)$

(20) \{□_C R(a) \land \neg □_C R(b), □_C R(b) \land \neg □_C R(a)\} (PDAs)
The Viability Constraint (VC) Analysis

Numeral *any* is split (num + *any*), *any* scopes under □.

(21) \[\text{two } \lambda_2 \text{ must}_C \left[ \text{any } t_2-\text{MANY books}_D \right] \lambda_1 \text{ Bill reads } t_1] = \square_C [R(a \oplus b) \lor R(b \oplus c) \lor R(a \oplus c)]

This derives the same interpretation as the WSCA.

Viability is satisfied in models below that satisfy universal permission:

| w_1   | R(a \oplus b) \land \neg R(b \oplus c) \land \neg R(a \oplus c) |
| w_2   | R(b \oplus c) \land \neg R(a \oplus b) \land \neg R(a \oplus c) |
| w_3   | R(a \oplus c) \land \neg R(a \oplus b) \land \neg R(b \oplus c) |
Assessing the analyses
Collective predicates

The WSCA and VCA make different predictions when numeral *any* combines with collective predicates, as in (22):

(22) John must mix any two drinks
Collective predicates: the WSCA

(23) John must mix any two drinks.

Predicted to convey:

1. that J. is required to mix all pairs of drinks ((24-a) & (24-b))
2. that he is not required to mix a larger group of drinks (24-c)

(24)  

a. $\Box M(a \oplus b) \lor \Box M(b \oplus c) \lor \Box M(a \oplus c)$ (assertion)

b. $\Box M(a \oplus b) \leftrightarrow \Box M(b \oplus c) \leftrightarrow \Box M(a \oplus c)$ (domain implicature)

c. $\neg \Box M(a \oplus b \oplus c)$ (negation of scalar implicature)
Collective predicates: the WSCA

Scale Economy Condition does not block wide scope with collectives:

(25) John must mix any two drinks.

\[ \leadsto \text{J. is required to mix all pairs of drinks and he is not required to mix a larger group of drinks.} \]

(26) John must mix any three drinks.

\[ \leadsto \text{J. is required to mix all groups of three drinks and he is not required to mix a larger group of drinks.} \]

No reason to reconstruct below the modal and violate the Wide Scope Constraint.
Collective predicates: the WSCA

(27) John must mix any two drinks.

- John is required to mix all pairs of drinks (and not required to mix a larger group of drinks).

(28) Bar tender competition (I). Do all cocktails. There is coke, whiskey, and gin. John is required to mix coke and whiskey, coke and gin, and whiskey and gin.

(29) Bar tender competition (II). Choose your cocktail. Same drinks. John is permitted to mix any couple of drinks. He is required to mix at least one pair, but not required to mix any particular pair.

(27) predicted to be true in (28), false in (29).
Collective predicates: the VCA

(30)  John must mix any two drinks.

VCA predicts (30) to assert (31-a) and implicate (31-b). VC requires all terms of the biconditional to be false.

• John is required to mix a couple of drinks, not required to mix any particular group, and permitted to mix any.

(31)  a.  □[M(a ⊕ b) ∨ M(b ⊕ c) ∨ M(a ⊕ c)]
    b.  □M(a ⊕ b) ↔ □M(b ⊕ c) ↔ □M(a ⊕ c)
    c.  ¬□M(a ⊕ b ⊕ c)
Collective predicates: the VCA

(32) John must mix any two drinks.

• John is required to mix a couple of drinks, not required to mix any particular group, and permitted to mix any.

(33) Bar tender competition (I). Do all cocktails. There is coke, whiskey, and gin. John is required to mix coke and whiskey, coke and gin, and whiskey and gin.

(34) Bar tender competition (II). Choose your cocktail. Same drinks. John is permitted to mix any couple of drinks. He is required to mix at least one pair, but not required to mix any particular pair.

(32) predicted to be true in (34), false in (33).
Assessing the predictions

In scenarios like the previous ones, our informants side with the VCA rather than with the WSCA. In other words, numeral *any* + collective predicates derive an existential requirement rather than a universal requirement (i.e. mixing all drinks is required).
Open questions
The contrast between *any* and ‘numeral *any*’ is not universal.

XX: in Farsi, numeral *any* behaves as predicted by the WSCA with collective predicates.

What lies behind the attested cross-linguistic variation?
Thanks!
References

