

### Interactions of worlds, times, and locations: On the expressive power of index shifting

**Main claims:** In a nutshell, I argue that natural language has the expressive power of a system with object language quantification over *evaluation indices* (i.e. packages of index coordinates), but lacks the power of object language quantification over individual *index coordinates* (i.e. worlds, times, locations). The crucial evidence for this comes from (im-)possible interactions of the world-, time- and location-component of an index. Specifically, if one coordinate is dependent on a local intensional operator, other coordinates cannot take their value from a non-local source (i.e. there are no constructed indices where the coordinates of an index behave like independent variables).

**Introduction:** Denotations of predicates are dependent on an index of evaluation. Language can manipulate a predicate's index by embedding it under expressions (e.g. attitude verbs, tenses) that "shift" coordinates (e.g. the world, time, location) of the index. An important result of the last decades has been the generalization that natural language employs a logic of index shifting that has the expressive power of a system with object language quantification over worlds (e.g. [1]) and times (e.g. [1]-[2]). The same generalization can be drawn for the less-studied location coordinate: Similar to how the denotation of an expression may vary with the world or time of evaluation, certain predicates are arguably true of different individuals at different locations (e.g. *villager*, *mayor*, *tourist*, *visitor*). Moreover, the location coordinate (LC) displays the characteristics of an object language variable: (1) can have a reading in which the set of tourists co-varies with the locations in Europe, suggesting that the LC can be treated as a bound variable. In (2), the expression *the local mayor* can plausibly refer to the mayor of Appletown, the mayor of Snowville or the mayor of the utterance location. There is also an available reading in which the mayor co-varies with the villages that have a left-leaning government, i.e. where the LC of *the local mayor* is bound by the *wherever*-quantifier. Crucially, all these readings for *the local mayor* are compatible with a narrow scope construal for its host-DP *a person that represented [...]* with respect to the universal quantifier *at every meeting [...]* (i.e. at every meeting there may be a different representative of the local mayor that allegedly made a fascist salute). This implies that the LC of *the local mayor* can select its antecedent over an arbitrary structural distance, a property that matches the behavior of an object language variable.

(1) Wherever we went in Europe, *every tourist* was annoying.

(2) Context: *In a large rural county, there are only four villages that have a left-wing government.*

Wherever the government is left-leaning, the villagers will be outraged when they hear that in Snowville, people have been claiming that at every meeting of county politicians in Appletown a person that represented *the local mayor* made a fascist salute.

**Index variables vs. coordinate variables:** Previous literature has focused on the variable-like behavior of individual coordinates of the index. In this paper, I consider the implications of the emerging conclusion that *all* coordinates of the index (worlds, times and locations) display behavior that is consistent with object language quantification. Specifically, I want to contrast two plausible generalizations about index shifting that are both compatible with the existence of variable-like behavior in the modal, temporal and locational dimension of the index.

(3) **G1** (candidate generalization 1): Natural language has the expressive power of a system with object language quantification over *evaluation indices*.

(4) **G2** (candidate generalization 2): Natural language has the expressive power of a system with object language quantification over *index coordinates*.

G2 could for instance describe a system in which predicates combine with independent world, time and location variables in the syntax. G1 could describe a system in which the world, time and location specification of a predicate is collapsed into a single object language index variable. Crucially, G2 describes a system with greater expressive power than G1. Specifically, only a system with the power of G2 allows *constructed evaluation indices* (CI). A CI is an index where the values for two (or more) of its coordinates depend on independent sources, e.g. a local and a non-local intensional operator. In this talk, I conclude that there is no evidence for the existence of CIs. This suggests that the system of index shifting employed by natural language is best described by G1, not G2.

(5) **Hypothesis:** Natural language does not allow constructed evaluation indices.

- a. \*OP<sub>1</sub> ... OP<sub>2</sub> ... <α<sub>2</sub>, β<sub>1</sub>><sub>i</sub>                      b. \*OP<sub>1</sub> ... OP<sub>2</sub> ... <α<sub>1</sub>, β<sub>2</sub>><sub>i</sub>

(where α, β are two coordinates of the index *i* and OP<sub>1</sub> and OP<sub>2</sub> are two intensional operators)

**Evidence:** The examples below involve an attitude holder that is confused about her location. The locational information introduced by the attitude verb (the “opaque” location) is therefore substantially different from the attitude holder’s actual location (the “transparent” location), which is specified by a locational quantifier (*wherever [...]*) outside of the intensional context. What the examples show is that the location value of the DP *the local mayor* is predictable from its world value: In (6), the location coordinate cannot be bound by the attitude verb (i.e. refer to Alice’s self-ascribed location) if the DP has a transparent world coordinate. Crucially, the relevant reading would describe a sensible attitude that is actually held by the subject in this context. (7) shows that the converse opaque-world+transparent-location-reading (i.e. the location is bound by the belief-external location quantifier on a modally opaque reading) is impossible as well. Although the relevant examples have been omitted here, it should be obvious that the opaque+opaque- and transparent+transparent-readings are both possible.

(6) **Context (transparent-world+opaque-location):** *Alice has a condition called “Snowville syndrome”: Regardless of where she is, she always believes to be in Snowville. Researchers set up an experiment: They question Alice in four distinct towns (AT, WT, BT, and ST). At each location, Alice is interviewed by a local friend, i.e. she is interviewed by an AT-resident in AT, a WT-resident in WT, etc. The result: At each location, Alice wrongly identifies her location as Snowville. Moreover, she never correctly identifies her interlocutor and instead always claims she is talking to her brother Bob. Bob is in fact the actual mayor of Snowville. However, Alice does not know this. When asked about her brother, she for some reason claims that the mayor of Snowville is Susan. The researchers summarize:*

#Wherever she was interviewed, Alice believed she was talking to *the local mayor*.

(*the local mayor* ≈ the x that is the actual mayor of the location Alice believes to be in)

(7) **Context (opaque-world+transparent-location):** *Gina has a condition called “Snowville syndrome”: Regardless of where she is, she always believes to be in Snowville. Researchers set up an experiment: They question Gina in four distinct towns (AT, WT, BT, and ST). At each location, Gina is interviewed by a local friend, i.e. she is interviewed by an AT-resident in AT, a WT-resident in WT, etc. The result: At each location, Gina wrongly identifies her location as Snowville. Moreover, although she correctly identifies the interlocutors and the towns they are from, she also believes them to be the mayors of their respective towns (She claims the AT-interviewer is AT’s mayor, the WT-interviewer is WT’s mayor, ...). She is wrong about all of them. None of her interlocutors was ever interested in becoming a politician. Interestingly, at each interview, she is nevertheless able to correctly name the mayor of Snowville. The researchers summarize:*

#Wherever she was interviewed, Gina believed she was talking to *the local mayor*.

(*the local mayor* ≈ the x Gina believes is the mayor of the location she is actually in)

**Additional evidence and potential counterexamples:** Because of space limitations, the abstract focuses on relevant examples from world-location interactions. However, analogous examples from world-time interactions will be included in the final paper. Some relevant examples involve tenses in relative clauses. For instance, when the attitude holder is mistaken about his temporal location, it can be shown that the relative clause tense in (8) cannot be a bound by a belief-external whenever-quantifier if the relative clause predicate is modally opaque (Importantly, this restriction is independent of scope).

(8) Whenever we interviewed Kurt after he woke up, he thought that the man *who worked for the CIA* was carrying a gun.

(9) Alice thinks *a student* killed Barry in the 1980s.

Potential counterexamples against the ban on CIs come from world-time interactions of nominal predicates. (9), for example, seems to allow a reading in which the noun is evaluated relative to the actual world (the attitude holder might not know the individual was a student) but also at the time of the embedded tense (it might be someone who was a student when the murder took place). Although this example might look like it involves a CI, I argue that it actually reveals that the temporal evaluation of DPs involves more than just a variable component. Specifically, it involves an index variable (or something of variable-like power) *and* an existentially quantified component (e.g. [3]) that is restricted by the index time. It is this second component that makes it seem as if (9) violated the CI generalization.

**References:** [1] Cresswell, Max. 1990. *Entities and Indices*. Dordrecht: Kluwer Academic Publishers. / [2] Kamp, Hans. 1971. Formal Properties of ‘Now’. *Theoria* 32(3). 227-273. / [3] Schwarz, Florian. 2012. Situation pronouns in determiner phrases. *Natural Language Semantics* 20. 431-475.