The Semantics of Corrections

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1 Introduction

Consider the sentences in (1):

(1) a. Andrew, *uh, sorry*, [Anders]$_F$ ate a taco. (full correction)
b. Anders made, *uh, sorry*, [ate]$_F$ a taco. (elliptical correction)
c. Anders made, *uh, sorry*, he [ate]$_F$ a taco. (anaphoric correction)

In each sentence, the speaker makes a mistake, signals that they've made a mistake (*uh, sorry*), and finally corrects their mistake.[1]

We will refer to the underlined material as the ANCHOR (a.k.a. *reparandum*; see Shriberg 1994), the italicized material as the TRIGGER (a.k.a. editing term), all subsequent material as the CORRECTION (a.k.a. alteration + continuation), and the anchor-correction pair as the (ERROR) CORRECTION STRUCTURE. We will abstain from explicitly annotating subsequent examples.

'Repair' / 'revision' cases comparable to the above have been given significant attention in psychology (e.g. Levelt 1983), psycholinguistics (e.g. Clark & Fox Tree 2002, Ferreira et al. 2004), conversation analysis (e.g. Schegloff et al. 1977) and computational linguistics (e.g. Heeman & Allen 1999, Hough & Purver 2012) but these phenomena have not been given much attention in generative linguistics, with the recent exception of Ginzburg et al. (2014), who analyze error corrections as a special type of clarification requests (Purver 2004).

Ginzburg et al. 2014 analyze corrections within an incremental dialogue understanding framework, and seek to unify them with other forms of disfluency. We will pursue a distinct line of investigation focusing specifically on correction structures from a grammatical perspective, though what we unearth will

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[1] We expect that many of the generalizations we propose about self-corrections will extend to cross-speaker corrections, but we will not be discussing such data here.

be of interest to theories of incremental interpretation. We will be particularly concerned with interactions between correction structures and: (i) contrastive focus, building on Segmented Discourse Representation Theory (SDRT) and related approaches; see van Leusen (1994, 2004), Asher & Gillies (2003), Asher & Lascarides (2009), (ii) propositional anaphora, and (iii) anaphora to quantificational dependencies.

In section §2, we begin by considering (and casting doubt on) the intuitive analysis that error correction structures are a form of revision that creates a single proposition out of (parts of) the anchor and correction. We then look at the data in closer detail in section §3 and argue that the anchor and correction are parsed as separate clauses, based on facts involving contrastive focus, telescoping, and propositional anaphora. Section §4 follows up with a brief proposal for a formal semantics and formal pragmatics of corrections. The final section §5 provides a summary and outlines potential directions for future work.

2 The Snip & Glue Approach

Previous analyses (notably Asher & Gillies 2003, Asher & Lascarides 2009, Ferreira et al. 2004, Heeman & Allen 1999, Ginzburg et al. 2014, van Leusen 1994, 2004), though couched in very different frameworks, all pursue versions of a 'snip & glue' approach: the interpretation of correction structures proceeds by removing mistaken material and replacing it with corrected material – the mistaken portion of the anchor is deleted (snip) and the correction is attached to what remains of the anchor (glue). The result of the interpretational process is a single meaning assigned to a single sentence.

We have three empirical arguments that any snip & glue treatment of corrections (on its own) is inadequate: (i) error correction structures are a kind of contrastive structure (see van Leusen 1994, 2004, Asher & Gillies 2003, Asher & Lascarides 2009 for similar observations); (ii) anaphora in error correction structures behaves like anaphora between sentences; and finally (iii) propositional anaphora to either half of the correction structure is possible. In the next section, we elaborate on each of these claims in turn.

3 The Empirical Ground

In this section, we overview the main empirical features of correction structures and indicate to what extent previous analyses account for these features.

3.1 Three Types of Corrections

We consider three types of corrections. First, we look at elliptical corrections: these are error correction structures in which the correction is missing otherwise obligatory syntactic material.

(2) ELLIPTICAL CORRECTIONS:
  a. Anders made, uh, sorry, [ate]$_F$ a taco.
  b. Anders made a taco, uh, sorry, [ate]$_F$.
  c. Anders made a taco, uh, sorry, [a chalupa]$_F$.[2]
  d. Andrew made a taco, uh, sorry, [Anders]$_F$.

These structures are the only kind examined at length by previous theorists. It is probably partly for this reason that snip & glue approaches to correction structures seem to be intuitively satisfying.

The second type is what we call full corrections – error correction structures in which the correction does not rely on the anchor for its interpretation.

(3) FULL CORRECTIONS
  a. Andrew, uh, sorry, [Anders]$_F$ ate a taco.
  b. Andrew ate, uh, sorry, [Anders]$_F$ ate a taco.
  c. Andrew ate a taco. Uh, sorry, [Anders]$_F$ ate a taco.

These structures are less obviously addressed by the snip & glue approach, but an intuitive approach might be to simply discard the anchor entirely.

The final type of corrections we consider is anaphoric corrections: the correction contains pronominal elements that rely on material from the anchor for their interpretation. These are the least studied type of corrections, and the most important for the account we will propose in this paper.

(4) ANAPHORIC CORRECTIONS
  a. Anders made, uh, sorry, he [ate]$_F$ a taco.

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[2] Note that a corresponding correction structure where the correction is a bare noun is infelicitous:

(1) # Anders made a taco, uh, sorry, [chalupa]$_F$.

This appears to be an idiosyncratic property of singular count nouns, as the following felicitous examples demonstrate:

(2) a. Anders made some tacos, uh, sorry, [chalupas]$_F$.
  b. Anders drank some water, uh, sorry, [soda]$_F$.

b. Anders made a taco, uh, sorry, he $[\text{ate}]_F$ it.
c. Anders made a taco, uh, sorry, he $[\text{ate}]_F$ one.
d. Anders made a taco, uh, sorry, $[\text{ate}]_F$ it.
e. Anders made a taco, uh, sorry, $[\text{ate}]_F$ one.
f. Every boy made, uh, sorry, he $[\text{ate}]_F$ a taco.
g. Every boy made some tacos, uh, sorry, they $[\text{ate}]_F$ them.

These structures are problematic for snip & glue approaches: the anaphoric dependencies suggest that anchor and correction are not interpretationally merged, and the interpretation of the anchor (although incorrect) is not discarded.

We argue that all three types of corrections deserve a unified account, and that snip & glue approaches on their own cannot provide such an account.

3.2 Corrections and Contrast

An important fact about corrections is that they must contain at least one focus-marked element. As the examples in (5) show, focus placement goes on the locus of correction. Furthermore, if there are multiple correction loci, the correction structure needs to have multiple foci, as shown in (6).

(5) a. Andrew, uh, sorry, $[\text{Anders}]_F$ ate a taco.
b. ? Andrew, uh, sorry, Anders ate a $[\text{taco}]_F$.

(6) a. Anders made a taco, uh, sorry, $[\text{ate}]_F$ a $[\text{chalupa}]_F$.
b. ? Anders made a taco, uh, sorry, $[\text{ate}]_F$ a chalupa.
c. ? Anders made a taco, uh, sorry, ate a $[\text{chalupa}]_F$.

All of these foci are contrastive: focus placement in the correction must correspond to the location of mistakes in the anchor, because those are the only places where the anchor and correction differ.[3] We assume Rooth's (1992) definition of contrast:

(7) Contrasting Phrases (Rooth 1992):
Construe a phrase α as contrasting with a phrase β iff $[\![\beta]\!]^{\mathrm{o}} \in [\![\alpha]\!]^{\mathrm{f}}$.

For any phrase α, $[\![\alpha]\!]^{\mathrm{o}}$ is the ordinary semantic value of α, and $[\![\alpha]\!]^{\mathrm{f}}$ is the 'focus-semantic value' of α, or the set of all ordinary semantic values derivable from α via replacement of focus-marked elements in α with elements of the same

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[3] Asher & Gillies (2003), Asher & Lascarides (2009), van Leusen (1994, 2004) already notice that the focus/background partition of the correction should be matched in the anchor. They ultimately propose a version of the snip & glue approach involving non-monotonic logics for Common Ground (CG) update.

semantic type.[4] For details on the notions of contrast and focus being assumed here, see Rooth (1992).

In order for the anchor and correction to be viewed as contrastive in the Roothian sense, each needs to have an independently calculable semantic value. A snip & glue account where the result is one semantic value built by combining the correction with cannibalized parts from the anchor will need to do something fairly complex to account for the focus facts.[5]

3.3 Corrections and Telescoping

The subtype of anaphoric corrections that we call telescoping corrections (see (4f)) are particularly relevant for understanding the semantics of corrections. The term telescoping refers to cross-sentential dependencies between singular pronouns and quantifiers. The set of quantifiers that participate in telescoping is quite small (examples from/based on Roberts 1987):

(8) a. {Every, Each} boy walked to the stage. He shook the President's hand and returned to his seat.[6]
b. * {No, Most, Half of the, Twenty} boys walked to the stage. He shook the President's hand and returned to his seat.

In contrast, the set of quantifiers that can be picked up cross-sententially by a plural pronoun is larger (see (4g) for a parallel correction structure):

(9) a. {Every, Each} boy walked to the stage. They shook the President's hand and returned to their seats.
b. {Most, Half of the, Twenty} boys walked to the stage. They shook the President's hand and returned to their seats.
c. * No boy(s) walked to the stage. They shook the President's hand and returned to their seats.

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[4] Contrastive focus can be applied to elements that differ only in terms of pronunciation (see Artstein 2004 for details), and, as expected if corrections are indeed contrast structures, such elements participate in correction structures as well:

(1) Anders ate a tomahto, uh, sorry, a to[may]$_F$to.

[5] For example, the SDRT approach in Asher & Gillies (2003) has multiple layers of representation and multiple logics associated with these layers. Focus/background information is represented in a 'lower' layer and CG update is performed in a 'higher'-level logic that non-monotonically reasons over and integrates the lower-level representations.

[6] Generally a plural pronoun strategy is preferred to the telescoping strategy, but telescoping is at least marginally grammatical. We've found in our own experimental work (not reported here) that the same is true for telescoping in corrections.

Strikingly, we see the exact same restrictions applying to relations between quantifiers and pronouns in error correction structures:

(10) a. {Every, Each} boy made, uh, sorry, he $[\text{ate}]_F$ three tacos.[7]
b. * {No, Most, Half of the, Twenty} boys made, uh, sorry, he $[\text{ate}]_F$ three tacos.

(11) a. {Every, Each} boy made, uh, sorry, they $[\text{ate}]_F$ some tacos.
b. {Most, Half of the, Twenty} boys made, uh, sorry, they $[\text{ate}]_F$ some tacos.
c. * No boy(s) made, uh, sorry, they $[\text{ate}]_F$ some tacos.[8]

These parallels in singular/plural anaphora behavior indicate that anaphora between anchors and corrections behaves like anaphora between *separate sentences*, not like within-sentence binding. Importantly, the telescoping facts are unexpected for snip & glue accounts, which merge anchor and correction into a single sentence.

3.4 Corrections and Propositional Anaphora

Error correction structures allow propositional anaphora with *that* to either the interpretation of the anchor or the interpretation of the correction:

(12) a. **A:** Anders ate fifty, uh, sorry, he ate $[\text{five}]_F$ tacos.
B: That would've been crazy!
b. **A:** Anders ate fifty, uh, sorry, he ate $[\text{five}]_F$ tacos.
B: That's much easier to believe!

It is unclear how this would be explained from the perspective of a snip & glue account, in which the anchor is never assigned a full interpretation. SDRT-style accounts, for example, could capture this because they countenance two representational layers, one of which contains two discourse representation structures for the anchor and the trigger – assuming propositional anaphora resolution happens at the 'right' point and takes advantage of the 'right' representational layer. However, we believe that all these empirical characteristics of error correction structures can be accounted for in a simpler way, outlined in (14) below.

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[7] We were first made aware of examples of this kind by Milward & Cooper (1994), though those authors do not note their theoretical significance.

[8] Cases like this are better with polarity reversal:

(1) No boy made, uh, sorry, they $[\text{did}]_F$ make some tacos.

4 Proposal

In section (3.2), we argued that error correction structures are contrastive structures. We discussed the contrastive nature of corrections in Roothian terms: we need to identify a suitable part of the anchor that can provide the antecedent for the focus anaphor contributed by the correction; this is closely related (but not identical) to the SDRT proposal that the focus-background partitions of the correction and anchor should match (van Leusen 1994, 2004, Asher & Gillies 2003, Asher & Lascarides 2009).

It is easy to see how a contrast relation can be established between the correction and the anchor if both of them are complete—as in (13a). However, establishing the contrast relation is trickier if the anchor or the correction or both are incomplete—as in (13b).

(13) a. Anders ate a taco. Uh, sorry, Anders ate a [chalupa]$_F$.
     b. Anders ate, uh, sorry, [made]$_F$ a taco.

Given the need to establish a contrast rhetorical relation, we hypothesize the following semantics for corrections:

(14) a. CONTRAST-DRIVEN THEORY OF CORRECTION INTERPRETATION (BROAD STROKES):
Fill in missing material in the anchor and correction in whatever way will result in the ordinary semantic value of the anchor being a member of the focus semantic value of the correction.
     b. CONTRAST-DRIVEN THEORY OF CORRECTION INTERPRETATION (THINNER STROKES):
Formalization in Compositional DRT (CDRT; Muskens 1996) – see section 4.1 below.

We also propose the following additional semantic/pragmatic component associated with the interpretation of error correction structures (closely following the proposal in Ginzburg et al. 2014):

(15) THE DISCOURSE EFFECT OF ERROR CORRECTION STRUCTURES:
Upon calculation of the relation of contrast between the correction and the anchor:

- the speaker's commitment to the anchor is canceled
- the speaker's commitment to the correction is asserted
- the only commitment placed on the table (in the sense Farkas & Bruce 2010) as a Common Ground (CG) update proposal is the one contributed by the correction

In order to interface with standard models of the formal pragmatics of CG update that treat propositions as sets of worlds (see e.g. Stalnaker 1978), our formalization presented in section (4.1) is couched in a possible-world-based compositional semantics.

4.1 Formalization in CDRT

In this section, we put forth a basic formalization of our proposal for the semantics of error correction structures in (14) above. We build on CDRT and add:

- discourse referents (drefs) for propositions
- logical forms of the kind needed for focus semantics (or parasitic scope)

Our system has the following basic types: e (entities), t (truth values), s (variable assignments) and $\mathbf{w}$ (possible worlds). For simplicity, and to explicitly indicate that the compositional aspects of the system largely follow classic Montagovian semantics, we introduce the following abbreviations:

(16) Type abbreviations:

a. $\mathbf{e} \coloneqq se$; 'individuals' are drefs for individuals, basically individual concepts

b. $\mathbf{s} \coloneqq s(\mathbf{w}t)$; intensionality: sentences are interpreted relative to the current assignment and the current proposition/set of worlds that are live candidates for the actual world

c. $\mathbf{t} \coloneqq s(st)$; the interpretation of a sentence is a DRS, i.e., a binary relation between an input and an output assignment – see also DPL formulas, Groenendijk & Stokhof (1991)

A discourse referent (dref) for individuals $u_{\mathbf{e}}$ is of type $\mathbf{e} \coloneqq se$. That is, a dref for individuals is basically an individual concept: it denotes an individual (type e) relative to a context of interpretation / variable assignment (type s). Similarly, a dref for propositions $p_{\mathbf{s}}$ is of type $\mathbf{s} \coloneqq s(\mathbf{w}t)$. A propositional dref denotes a set of worlds (type $\mathbf{w}t$) relative to a variable assignment.

Given that we intensionalize our logic with plural propositional drefs rather than singular possible-world drefs, we have to decide how to interpret lexical intensional relations:

(17) **Lexical relations**. When an intensional n-ary static lexical relation R of type $\mathbf{w}(e(e(\ldots t)))$ is interpreted relative to a propositional dref $p_{\mathbf{s}}$, it is interpreted distributively relative to the worlds in p:
$R_p(u_1, \ldots, u_n) \coloneqq \lambda i_s.\ \forall w_{\mathbf{w}} \in pi\ (R(w)(u_1 i) \ldots (u_n i))$

With lexical relations in place, we can introduce basic discourse representation structures (DRSs).

(18) **Basic DRSs**.

a. We abbreviate introducing drefs $\nu_1, \dots, \nu_n$ as: $[\nu_1, \dots, \nu_n]$

b. We abbreviate a DRS that contains only conditions $C_1, \dots, C_n$ as: $[C_1, \dots, C_n]$

c. Dynamic conjunction is symbolized as ';'; for two DRSs D, D' of type $\mathbf{t}$, we have that:
$D; D' := \lambda i_s.\lambda j_s.\ \exists k_s(Dik \wedge D'kj)$, where '$\wedge$' is classical static conjunction

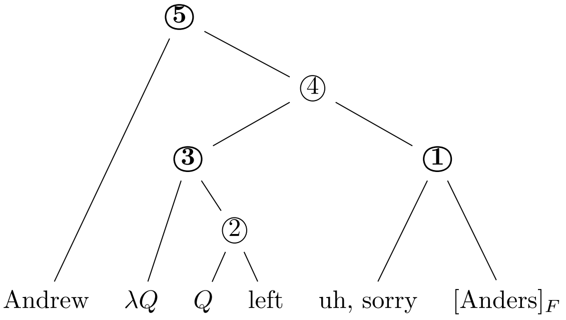
d. A DRS $[\nu_1, \dots, \nu_n|\ C_1, \dots, C_n]$ introducing some drefs and contributing some conditions is just the abbreviation of the dynamic conjunction $[\nu_1, \dots, \nu_n];\ [C_1, \dots, C_n]$.

A simple error correction structure like (19) is interpreted as in (20):

(19) Andrew left, uh, sorry, $[\text{Anders}]_F$.

(20) a. *uh, sorry* $\rightsquigarrow \lambda A_\alpha.\lambda B_{\alpha(\mathbf{st})}.\lambda A'_\alpha.$
$[p_1, p_2];\ B(A')(p_1);\ B(A)(p_2);\ CG \mathrel{+}= p_2$

b.



c. ① $\rightsquigarrow \lambda B_{((\mathbf{est})\mathbf{st})\mathbf{st}}.\lambda A'_{(\mathbf{est})\mathbf{st}}.\ [p_1, p_2];\ B(A')(p_1);$
$B(\lambda P_{\mathbf{est}}.\lambda p_{\mathbf{s}}.\ [u_2|\ u_2 = \text{ANDERS}];\ P(u_2)(p))(p_2);\ CG \mathrel{+}= p_2$

③ $\rightsquigarrow \lambda Q_{(\mathbf{est})\mathbf{st}}.\lambda p_{\mathbf{s}}.\ Q(\lambda x_{\mathbf{e}}.\lambda p_{\mathbf{s}}.\ [\text{LEAVE}_p(x)])(p)$

⑤ $\rightsquigarrow [p_1, p_2, u_1, u_2|\ u_1 = \text{ANDREW},\ \text{LEAVE}_{p_1}(u_1),$
$u_2 = \text{ANDERS},\ \text{LEAVE}_{p_2}(u_2)];\ CG \mathrel{+}= p_2$

In (20c), we assume a Lewis-style typing with the 'intensionalization' type $\mathbf{s}$ being innermost (closest to the type of sentences $\mathbf{t}$). We also assume Montagovian type lifts for proper names, which are of type $(\mathbf{e}(\mathbf{st}))(\mathbf{st})$, e.g.,

$$\textit{Anders} \rightsquigarrow \lambda P_{\mathbf{e}(\mathbf{st})}.\lambda p_{\mathbf{s}}.\ [u_2|\ u_2 = \text{ANDERS}];\ P(u_2)(p)$$

Variables are subscripted with their types. We assume complex types associate to the right and we usually omit parentheses indicating association to the right, e.g., instead of $\mathbf{e}(\mathbf{st})$ and $(\mathbf{e}(\mathbf{st}))(\mathbf{st})$, we usually write $\mathbf{est}$ and $(\mathbf{est})\mathbf{st}$.

As (20a) shows, the trigger contributes the crucial operator relating the correction to the anchor.[9] This operator takes three arguments:

- the correction A_α (the type α is underspecified and is dictated by the correction itself)—this is *Anders* in our case;
- the mistaken part of the anchor A'_α that must have the same type as the correction—this is *Andrew* in our case;
- the remaining part of the anchor $B_{\alpha(\mathbf{st})}$ that can be predicated of both A and A'—this is a type-lifted version of *left* in our case; this type lifting happens systematically as a consequence of (i) the mistake *Andrew* scoping out of the anchor and (ii) the trigger+correction *uh, sorry, Anders* taking (parasitic) scope immediately under the scoped-out mistake.

The logical form (LF) in (20) is the result of establishing anchor-correction contrast. That is, the trigger+correction constituent (*uh sorry, Anders* in this case) adjoins at a point that divides the anchor in two parts: (i) one part of the anchor is the mistake (*Andrew* in our case), and enters in a contrastive relation with the correction (that is, the ordinary semantic value of the mistake is a member of the focus semantic value of the correction); (ii) the second part of the anchor (*left*, or a type-lifted version thereof, in this case) can be predicated of both the mistake and the correction. That is, LFs for correction structures are derived via the following informal algorithm:

(21) Correction LF generation algorithm (first pass):

I. Adjoin the trigger (the correction operator) to the correction.
II. Adjoin the anchor to the resulting structure.
III. Identify that portion of the anchor that is a member of the focus semantic value of the correction, and move it to an adjoining position, leaving in place a variable and lambda-abstractor of the appropriate type.[10]

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[9] We've represented the trigger *uh, sorry* as a lexical item contributing the crucial operator relating the correction to the anchor. This is a convenient notational choice that indicates no deep assumption of our theory; we assume that the correction operator is available independently of the way a speaker indicates that they're making a correction, which may in principle be non-verbal.

[10] This step of the algorithm enforces the contrast generalization from §3.2. Note, however, that it does not rule out superfluous focus placement, as in the following infelicitous example:

(1) # Anders made a taco, uh, sorry, $[\text{ate}]_F$ a $[\text{taco}]_F$.

In this case, the VP of the anchor is indeed a member of the focus semantic value of the correction, as *taco* is (trivially) of the same semantic category as itself. This problem could be solved by adding a constraint against triviality to the generation of focus alternatives, ruling out focus alternatives that include the ordinary semantic values of focus-marked elements.

In this case, the correction is *[Anders]$_F$*, and the portion of the anchor that is a member of the focus semantic value of *[Anders]$_F$* is *Andrew*. Therefore, *Andrew* is scoped over the correction structure, leaving a lambda abstractor over a variable of type (**est**)**st**.

Once the correction operator in (20a) takes its arguments, it introduces two propositional drefs p_1 and p_2 for the anchor and the correction respectively, and requires only the p_2 dref to be added to the CG.

In the simple example in (20), the partition of the anchor induced by the adjunction site of the trigger+correction constituent is fairly directly related to the SDRT idea that the partitioning of the anchor matches the focus-background partition of the correction. In general, however, our account does not require the focus-background of the correction and of the anchor to match. We simply require the trigger+correction adjunction site to partition the anchor in such a way that one part of it (the mistake) contrasts with the correction, and the remaining part can be predicated of both correction and mistake. The difference between our proposal and the SDRT focus/background matching proposal becomes clear when we consider multiple correction loci, which are associated with multiple foci. For example, according to our proposal, the LF of (6a) above would partition the anchor into the mistake *made a taco* and the remaining part of the anchor *Anders*. And we would require the ordinary value of the entire mistake *made a taco* to be a member of the focus value of the entire correction *[ate]$_F$ a [chalupa]$_F$*.[11]

In sum, error correction structures show that the clause-like semantic values of both the anchor and the correction become part of the interpretation context but in different ways: only the correction ends up being added to the CG, but the interpretation of the anchor is crucial for establishing anchor-correction contrast and also for providing suitable antecedents for anaphors in the anchor (see the anaphoric corrections discussed in section 3.1).

In order for our proposal to generalize across all types of correction structures, the algorithm in (21) must be made somewhat more complex. The most complex cases are corrections in which the anchor is missing syntactically obligatory material, as in the elliptical correction in (2a). In (2a), the verb *made* in the anchor is missing its direct object. Because of this, we need to derive an LF for it like the one in (23a), where that missing direct object slot is filled in with a variable Q, and the direct object of the correction, *a taco*, moves up to take scope over the entire anchor-correction structure so that it can bind both direct object variables. This type of LF is familiar from Right Node Raising constructions (e.g., *Jane likes and Bill hates this kind of sea salt caramels*), and

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[11] As we already indicated in fn. 10, we assume that the multiple foci in the correction induce a suitable focus semantic value for the entire correction: assuming that 'contrastive' focus semantic values do not include ordinary values, we require that when multiple foci are present, any alternative that contains the ordinary value of any of the foci should be excluded from the focus value.

the intonational contour associated with correction structures like (2a) seems to be very similar to such Right Node Raising constructions. To derive LFs like (23a), we need to make two additions to the informal LF generation algorithm above:

(22) Correction LF generation algorithm (final pass):

I. Adjoin the trigger (the correction operator) to the correction.

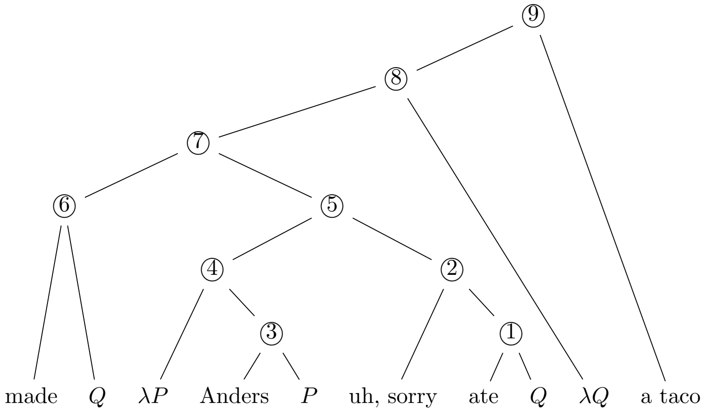
II. Adjoin the anchor to the resulting structure.

III. Insert a variable of the appropriate type to fill in missing syntactically obligatory structure.

IV. Identify that portion of the anchor that is a member of the focus semantic value of the correction, and move it to an adjoining position, leaving in place a variable and lambda-abstractor of the appropriate type.

V. Identify that portion of the correction that corresponds to an unbound variable in the anchor, and move it to an adjoining position so that it can take scope over that variable.

(23) a. LF for (2a):



b. a taco $\rightsquigarrow \lambda P_{\mathbf{e(st)}}.\lambda p_{\mathbf{s}}.\ [u_2|\ \textsc{taco}_p(u_2)];\ P(u_2)(p)$

② $\rightsquigarrow \lambda Q'_{\mathbf{(est)st}}.\lambda P'_{\mathbf{est}}.\ [p_1, p_2];\ Q'(P')(p_1);$
$Q'(\lambda x_{\mathbf{e}}.\lambda p_{\mathbf{s}}.\ Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.\ [\textsc{eat}_p(x, x')])(p))(p_2);\ CG \mathrel{+}= p_2$

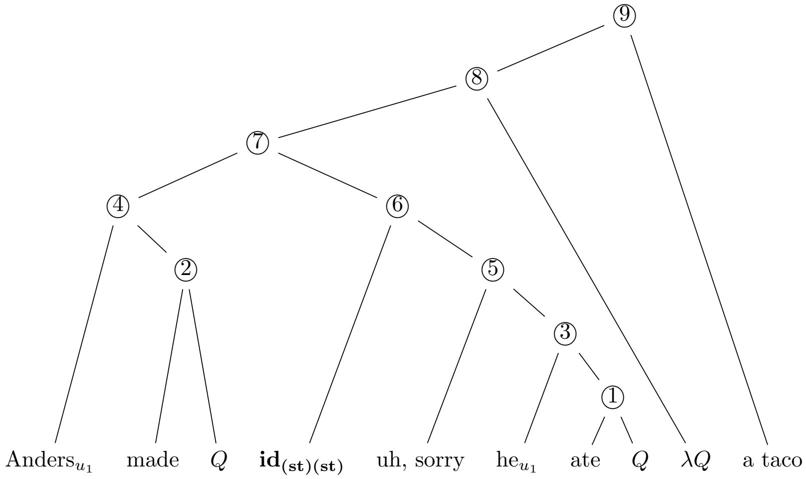
⑤ $\rightsquigarrow \lambda P'_{\mathbf{est}}.\ [p_1, p_2, u_1|\ u_1 = \textsc{Anders}];\ P'(u_1)(p_1);$
$Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.\ [\textsc{eat}_p(u_1, x')])(p_2);\ CG \mathrel{+}= p_2$

⑦ $\rightsquigarrow [p_1, p_2, u_1|\ u_1 = \textsc{Anders}];\ Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.[\textsc{make}_p(u_1, x')])(p_1);$
$Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.[\textsc{eat}_p(u_1, x')])(p_2);\ CG \mathrel{+}= p_2$

⑨ $\rightsquigarrow [p_1, p_2, u_1|\ u_1 = \textsc{Anders}];\ [u_2|\ \textsc{taco}_{p_1}(u_2),\ \textsc{make}_{p_1}(u_1, u_2)];$
$[u_2|\ \textsc{taco}_{p_2}(u_2),\ \textsc{eat}_{p_2}(u_1, u_2)];\ CG \mathrel{+}= p_2$

Anaphoric corrections like (4a) are analyzed as shown in (24a). To maintain the general format for the correction operator contributed by *uh, sorry*, we assume the covert insertion of a node denoting the identity function $\mathbf{id}_{\mathbf{(st)(st)}}$ over objects of type $\mathbf{st}$. This is for convenience only, we could also generalize the interpretation of the correction operator in a suitable way.

(24) a. LF for (4a):



b. $\mathbf{id}_{\mathbf{(st)(st)}} \rightsquigarrow \lambda\mathcal{D}_{\mathbf{st}}.\,\mathcal{D}$

he$_{u_1}$ $\rightsquigarrow \lambda P_{\mathbf{e(st)}}.\lambda p_{\mathbf{s}}.\ P(u_1)(p)$

⑤ $\rightsquigarrow \lambda f_{\mathbf{(st)(st)}}.\lambda\mathcal{D}_{\mathbf{st}}.\ [p_1, p_2];\ f(\mathcal{D})(p_1);$
$f(Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.\,[\textsc{eat}_p(u_1, x')]))(p_2);\ CG \mathrel{+}= p_2$

⑥ $\rightsquigarrow \lambda\mathcal{D}_{\mathbf{st}}.[p_1, p_2]; \mathcal{D}(p_1); Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.[\textsc{eat}_p(u_1, x')])(p_2); CG \mathrel{+}= p_2$

⑦ $\rightsquigarrow [p_1, p_2, u_1|\ u_1 = \textsc{Anders}];\ Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.[\textsc{make}_p(u_1, x')])(p_1);$
$Q(\lambda x'_{\mathbf{e}}.\lambda p_{\mathbf{s}}.[\textsc{eat}_p(u_1, x')])(p_2);\ CG \mathrel{+}= p_2$

⑨ $\rightsquigarrow [p_1, p_2, u_1|\ u_1 = \textsc{Anders}];\ [u_2|\ \textsc{taco}_{p_1}(u_2),\ \textsc{make}_{p_1}(u_1, u_2)];$
$[u_2|\ \textsc{taco}_{p_2}(u_2),\ \textsc{eat}_{p_2}(u_1, u_2)];\ CG \mathrel{+}= p_2$

We present an alternative formulation of the interpretation of corrections couched in Categorial Grammar in Appendix A.

4.2 Telescoping Corrections

In this section we show how our account generalizes to telescoping error correction structures like (4f), or their plural counterparts (4g). We build on Dynamic Plural Logic (DPlL) (van den Berg 1996, Nouwen 2003) and Plural Compositional DRT (PCDRT) (Brasoveanu 2007), which recasts DPlL in classical type logic and incorporates discourse reference to possible worlds. DPlL/PCDRT enables us to treat updates with universal quantifiers in much the same way as updates with proper names or indefinites, so our CDRT account of anaphoric corrections like (4a)/(4b) can be straightforwardly generalized to (4f) and (4g).

The main difference between CDRT and DPlL/PCDRT is that updates are binary relations over sets of assignments of type $(st)((st)t)$, rather than binary relations over single assignments of type $s(st)$. Our type $\mathbf{t}$ therefore becomes $\mathbf{t} \coloneqq (st)((st)t)$. Since we work with sets of assignments, our 'intensionalization' type can simply be $\mathbf{s} \coloneqq s\mathbf{w}$, i.e., the type of drefs for possible worlds. The reason is that given a set of assignments I_{st} and a dref $p_{s\mathbf{w}}$, we retrieve a set of worlds (i.e., a proposition) as shown in (25). Introducing new drefs relative to a set of assignments (26) is just the cumulative-style generalization of introducing drefs relative to single assignments. Lexical relations are still interpreted distributively (27), but relative to a set of assignments rather than a propositional dref. Similarly, dynamic conjunction is still interpreted as relation composition (28). To handle quantifiers, we introduce a maximization operator $\mathbf{M}_u(D)$ that extracts the set of entities that satisfies the update D and stores it in dref u (29).

(25) $p_{s\mathbf{w}} I_{st} = \{pi : i_s \in I\}$ (pI is the image of I under function p)

(26) $[\nu_1, \ldots, \nu_n] \coloneqq \lambda I_{st}.\lambda J_{st}.\ \forall i_s \in I \exists j_s \in J(i[\nu_1, \ldots, \nu_n]j) \wedge \forall j_s \in J \exists i_s \in I(i[\nu_1, \ldots, \nu_n]j)$

(27) $R_p(u_1, \ldots, u_n) \coloneqq \lambda I_{st}.\ I \neq \varnothing \wedge \forall i_s \in I\ (R(pi)(u_1 i) \ldots (u_n i))$

(28) $D; D' \coloneqq \lambda I_{st}.\lambda J_s.\ \exists K_s(DIK \wedge D'KJ)$

(29) $\mathbf{M}_u(D) \coloneqq \lambda I_{st}.\lambda J_{st}.\ ([u]; D)IJ \wedge \neg \exists K_{st}(([u]; D)IK \wedge uJ \subsetneq uK)$

Universal quantification contributes a maximization operator over the restrictor, and the nuclear scope further elaborates on the maximal restrictor-satisfying dref (30). Singular or plural anaphora in subsequent sentences can pick up the maximal dref introduced by the universal *every*, in much the same way that the nuclear scope of an *every* quantification can pick up that dref and further elaborate on it. To properly distinguish between singular anaphora (telescoping) and plural anaphora, we need to extend the system with a notion of distributivity and a notion of discourse plurality/singularity. But the basic system outlined here is enough to show that we can now capture telescoping corrections in the same way we capture regular anaphoric corrections, as shown in (31) (cf. (24)).

(30) every$_u$ $\rightsquigarrow \lambda P_{\mathbf{est}}.\lambda P'_{\mathbf{est}}.\lambda p_{\mathbf{s}}.\ \mathbf{M}_u(P(u)(p));\ P'(u)(p)$

(31) Every$_{u_1}$ boy made, uh sorry, he$_{u_1}$ / they$_{u_1}$ ate a taco. $\rightsquigarrow$
$[p_1, p_2];\ \mathbf{M}_{u_1}([\textsc{boy}_{p_1}(u_1)]);\ [p'_1, u_2 | p'_1 \sqsubseteq p_1, \textsc{taco}_{p'_1}(u_2),\ \textsc{make}_{p'_1}(u_1, u_2)];$
$[u_2 | p_2 \sqsubseteq p_1, \textsc{taco}_{p_2}(u_2),\ \textsc{eat}_{p_2}(u_1, u_2)];\ CG \mathrel{+}= p_2$[12]

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[12] To derive the correct truth conditions, we need to introduce an additional propositional dref and suitable subset relations between propositional drefs to capture the fact that anaphora from the correction to a quantifier in the anchor builds on part of the content contributed by the anchor. The subset relations $p'_1 \sqsubseteq p_1$ and $p_2 \sqsubseteq p_1$ need to preserve the full dependency structure associated with the worlds in p_1. That is, for any p_1-world that we retain in the subsets p'_1 or p_2, we need to retain the full range of u_1-entities associated with that world.

5 Conclusion

We have argued that in error correction structures, the anchor and the correction are given separate interpretations, in opposition to standard accounts in which the output of an error correction structure is a single unified interpretation for the entire structure. On the basis of focus placement facts we have argued that error correction structures are a species of contrast structure. On the basis of telescoping facts, we have argued that the anchor and correction are treated as separate sentences. And finally on the basis of propositional anaphora facts, we have argued that the interpretation of the anchor is still accessible after the correction has been completed. In light of these facts, we conclude that snip & glue accounts of error correction are inadequate on their own.

One way to think about the present account of error corrections relative to the SDRT one or the one in Ginzburg et al. (2014) is that it tries to see how far we can get in a relatively unstructured version of dynamic semantics in which (i) we have only Dynamic Predicate Logic (DPL) + propositional drefs (+ the tech needed for subclausal compositionality) and (ii) we assume a monotonic version of incremental interpretation (no non-monotonic glue logic). An important point that emerges is that simply adding propositional drefs and incorporating a separate CG update that involves only some of these propositional drefs is enough to capture the basic interpretation of corrections. This enables us to incorporate telescoping corrections fairly easily because the basic DPL system can be generalized to a dynamic plural logic.

We will close by mentioning two broad follow-up questions. First, what is the fine-grained structure of elliptical corrections? Must corrections be constituents? What is the relation between error correction structures, fragment answers and better-studied forms of ellipsis, like gapping, stripping and sluicing? It is, to the best of our knowledge, a novel observation that error correction structures involve syntax/semantics ‘in the silence’ as Merchant (2001) puts it. Studying error correction structures as a new addition to the typology of elliptical constructions could significantly increase our understanding of the nature of structured silences in natural language.

Second, what new types of psycholinguistic evidence can correction structures provide about the fine details of incremental processing? How do listeners recognize that they’re hearing an error correction structure? What is the time course of correction interpretation and how does this vary between the three different types of corrections we studied? Are there processing costs associated with ‘filling in’ missing material? Finally, what happens when the target of the correction is ambiguous, e.g., *John recognized Mary, uh, sorry, Bill* (where *Bill* could correct either *John* or *Mary*)? What factors affect disambiguation for one resolution or another, e.g., identifying *John* or *Mary* as the target of correction in the example we just mentioned?

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A Categorial Grammar Formulation

Here we present an alternative syntactic account of error correction structures in categorical grammar that preserves our semantic account. For reasons of space we suppress non-propositional drefs, and work through non-quantified cases only. For full sentence corrections, the correction denotes a binary relation between sentences that updates the common ground only with the proposition associated with the correction:

$$\dfrac{\dfrac{\text{John left}}{\mathrm{S} : \textsc{leave}(j)} \qquad \dfrac{\dfrac{\text{uh, sorry}}{(\mathrm{S}\backslash\mathrm{S})/\mathrm{S} : \lambda A.\lambda A'.[p_1, p_2 | A'(p_1), A(p_2)]\ ;\ CG{+}{=}\ p_2} \qquad \dfrac{\text{John arrived}}{\mathrm{S} : \textsc{arrive}(j)}}{\mathrm{S}\backslash\mathrm{S} : \lambda A'.[p_1, p_2 | A'(p_1), \textsc{arrive}_{p_2}(j)]\ ;\ CG{+}{=}\ p_2}}{\mathrm{S}\!: [p_1, p_2 | \textsc{leave}_{p_1}(j), \textsc{arrive}_{p_2}(j)]\ ;\ CG{+}{=}\ p_2}$$

To handle partial corrections we generalize the type of the correction structure to denote a relation between verb phrases. The correction essentially builds a conjunction in which only the conjunct associated with the correction is added to the common ground.

$$\dfrac{\dfrac{\text{left}}{\mathrm{NP}\backslash\mathrm{S} : \textsc{leave}} \qquad \dfrac{\dfrac{\text{uh sorry}}{\begin{array}{l}((\mathrm{NP}\backslash\mathrm{S})\backslash(\mathrm{NP}\backslash\mathrm{S}))/(\mathrm{NP}\backslash\mathrm{S}) :\\ \lambda A.\lambda A'.\lambda x.[p_1, p_2 | A'(x)(p_1), A(x)(p_2)]\ ;\ CG{+}{=}\ p_2\end{array}} \qquad \dfrac{\text{arrived}}{\mathrm{NP}\backslash\mathrm{S} : \textsc{arrive}}}{(\mathrm{NP}\backslash\mathrm{S})\backslash(\mathrm{NP}\backslash\mathrm{S}) : \lambda A'.\lambda x.[p_1, p_2 | A'(x)(p_1), \textsc{arrive}_{p_2}(x)]\ ;\ CG{+}{=}\ p_2}}{\mathrm{NP}\backslash\mathrm{S} : \lambda x.[p_1, p_2 | \textsc{leave}_{p_1}(x), \textsc{arrive}_{p_2}(x)]\ ;\ CG{+}{=}\ p_2}$$

The correction then takes the subject as its final argument resulting in the desired update:

$$\dfrac{\dfrac{\text{John}}{\mathrm{NP} : j} \qquad \dfrac{\text{left uh sorry arrived}}{\mathrm{NP}\backslash\mathrm{S} : \lambda x.[p_1, p_2 | \textsc{leave}_{p_1}(x), \textsc{arrive}_{p_2}(x)]\ ;\ CG{+}{=}\ p_2}}{\mathrm{S} : [p_1, p_2 | \textsc{leave}_{p_1}(j), \textsc{arrive}_{p_2}(j)]\ ;\ CG{+}{=}\ p_2}$$

We also need to handle error correction structures which contain material between the correction and the constituent that needs to be replaced. This material needs to be made available both to the anchor and the correction. We utilize a pair forming operator $\circ$ that creates pairs of semantic values:

$$\frac{\mathrm{X} : \alpha \qquad \mathrm{Y} : \beta}{\mathrm{X} \circ \mathrm{Y} : \langle \alpha, \beta \rangle}$$

We now analyze error correction structures with intervening material in terms of pair formation. The correction, taking a verb to its right as its first argument, expects a verb-object pair to its left. It then feeds the object to both verbs:

$$\dfrac{\dfrac{\dfrac{\text{met}}{(\mathrm{NP}\backslash\mathrm{S})/\mathrm{NP} : \textsc{meet}} \qquad \dfrac{\text{Bill}}{\mathrm{NP} : b}}{((\mathrm{NP}\backslash\mathrm{S})/\mathrm{NP}) \circ \mathrm{NP} : \langle \textsc{meet}, b \rangle} \qquad \dfrac{\text{uh sorry saw}}{\begin{array}{l}(((\mathrm{NP}\backslash\mathrm{S})/\mathrm{NP}) \circ \mathrm{NP})\backslash(\mathrm{NP}\backslash\mathrm{S}) :\\ \lambda A'.\lambda x.[p_1, p_2 | A'(1)(A'(2))(x)(p_1), \textsc{see}_{p_2}(A'(2))(x)]\ ;\ CG{+}{=}\ p_2\end{array}}}{\mathrm{NP}\backslash\mathrm{S} : \lambda x.[p_1, p_2 | \textsc{meet}_{p_1}(b)(x), \textsc{see}_{p_2}(b)(x)]\ ;\ CG{+}{=}\ p_2}$$

The correction then takes the subject as its final argument, and generates the desired update:

$$\dfrac{\dfrac{\text{John}}{\text{NP} : j} \qquad \dfrac{\text{met Bill uh sorry saw}}{\text{NP}\backslash\text{S} : \lambda x.[p_1, p_2|\text{\textsc{meet}}_{p_1}(b)(x), \text{\textsc{see}}_{p_2}(b)(x)]\ ;\ CG\text{+=}\ p_2}}{\text{S} : [p_1, p_2|\text{\textsc{meet}}_{p_1}(b)(j), \text{\textsc{see}}_{p_2}(b)(j)]\ ;\ CG\text{+=}\ p_2}$$

This account avoids movement of the intervening material at the cost of introducing a pair-forming operator. This operator allows us to store the semantic value associated with the object so that it can be used to saturate the verb in both the anchor and the correction.

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