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Some Proposals for Junction Grammar

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SOME PROPOSALS FOR JUNCTION GRAMMAR

Mike McOmber

There are two methods available in processing JG operators. The first we will call Dominant processing (See figure 1). This is used in the case of mathematical subtypes of conjunction, for example, $5 + 3$. 8 is the result, and this value is assigned to the dominant node. This follows the standard procedure of algebraic structures. This resultant value 8 can then in turn be divided by two. The topmost node, or root of the tree is then assigned the value 4. 5, 3, and 2 are terms in the statement, and terminal nodes in the tree.

A second method of processing involves assignment to a terminal node, as in the case of interjunction in figure 2. First we take boy "and test . . . for cross-reference to an adjunctive environment . . . which matches that of who in the junction tree (who is wearing a hat). Assuming [an index of boy] does . . . match the prescribed environment, it . . . become[s] in effect the assigned value of who." This process of environment matching, or cross-referencing, is none other than intersection in set theory. It is just one operation or matching process that JG describes, but that fact is only indirectly reflected by the tree, which has five nodes and two operators. The resultant value is being assigned to a terminal node.

Were we to represent the math example in this way, we would have the following in figure 3, where again a terminal node is assigned the result of our 5 "in the [additive] environment of" 3. And what are the values for nodes A and D? $8 + 3 = 11$ has nothing to do with the original problem, $(5 + 3) \times 2 = 4$. Node D is extraneous to the wffs. In order to continue as before and divide 8 by 2, it becomes obvious that we must assign 8 to node A anyway. This makes the terminal assignment redundant. Following further instructions for the relative, we pick up another redundant terminal assignment (figure 4). The can be treated as a constant rather than a redundant variable.

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1M 125.
2D 438.
3M 65.
4P 227.

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Reversing this situation, let us place the relative clause in the more economical math format, where the dominant node is the sememe, sick boy. Note that this diagram uses half as many nodes and operators (figure 5).

It is inconsistent to use two methods in the same system. One will do, and can handle both situations more clearly, simply, and economically.

"The schematic expression for interjunction is \( Z \rightarrow X \cdot Y / D \). The elements of the formula correspond to the following tree fragment: [figure 6] \( Z \rightarrow XY \), and \( ZD \rightarrow Y \) are the corresponding production rules."\(^5\) Now, it is clear that \( Z \rightarrow XY \) corresponds to the JG rule \( X \cdot Y \nRightarrow Z \) where the juxtaposition of \( XY \) corresponds to the operation \( \cdot \). But what does the second rule correspond to? There is no such rule in the JG schemata, and no operation in the tree for \( ZD \). Leaving the operation out of the production rule in the JG discussion, and replacing it with juxtapositions obscures this fact. Calling the production rules "node-admissability conditions"\(^6\) doesn't alter the fact, or provide the missing operation.

Though we are told that JG trees may be generated top-to-bottom, or bottom-to-top,\(^7\) it has not been made clear whether we are to consider such generations as two distinctly directed graphs, or both of them as being one undirected graph.

Since directed graphs (diagraphs) allow any relation \( E \) for a graph \( G(V,E) \) we are concerned that in the formalism, a separate treatment is needed with a partial ordering \( R \) to produce trees. The subsequently required transform function is given, as the labelling function \( f \) "from the field of \( R \)."\(^8\) But we are not told specifically what this function is--its equations or mappings are missing. It cannot be the standard \( 1: V \rightarrow Av \) since, as we have seen, the production rules do not strictly correspond to the underlying algebra of JG. This function, however, becomes the crux of the for-

\(^5\) B 9, 10.


\(^7\) C 9.

\(^8\) D 292.

\(^9\) D 192
malization because it is the one part that would guarantee that our trees produced by R truly reflect and adequately represent derivations in JG. The formalization glosses over this in one line (figure 10).

The heart of the difficulty rests with the interpretation of the "link" node C of figure 9. For example, if * and + are to remain binary operators, we need two nodes for C at some point in the derivation. Each operator selects an appropriate n-tuple and assigns to it an image. This would give us 6 nodes rather than just 5, and two unchained trees. Two elements selected may have one and the same value, but that fact does not make them one and the same element, any more than two people with the same age are only one person. Preserving the laws for n-ary operators requires two C's, one node for each selection, and so far, two trees.

What do link numbers, or the slash symbol represent? We have two alternatives (see figure 11).

Alternative 1: The slash is a syntacto-semantic operator. Then, as with other such operators in JG it is to be represented by a triad in our graph, giving us a third dominant node. This violates the laws for operators since three operations require three distinct tuples (we are missing two nodes) and because it doesn't follow the partial order R of the formalism. It doesn't really resolve the identity problem of the two C's. Also note that the JG application of such a rule leads to an infinite recursion of intersect nodes and slashes (at exponential proportions) since each interjunction thus represented produces two more such interjunctions.

Alternative 2: The slash is not a syntacto-semantic operator but merely manipulates subtrees (see figure 12). This makes subtrees A and D separate bases which the slash post-operatively connects into one tree, making a double-

11A 22.

12 (2operations x 2pairs) + 2images.

The trees are unchained until the slash performs; i.e., after the other operators (* and +) that the C's participate in, have performed. If the slash is taken pre-operatively, then we are back to the first alternative, where the distinctness property of the tuples is violated.

14K 231. Even the TGians have abandoned this transformation.
base transformation. Nominalizations with repositioning of elements ("puppy" effect) as well as much of the various lexical rule components are further examples of transformationality in JG.

Either alternative 1 or 2 leads to a contradiction in JG.

OBJECTIONS

So far, objections to a diagram like boy * sick (figure 13) fall into the following categories:

Objection 1: The Nominalization

"The configuration [N * Adj V N] implies that the adjective is nominalized (note the dominant node), while sick in the sick boy is clearly not nominalized. The simplified structure, as it turns out, corresponds to a valid possibility, namely a nominalized adjective, sickness." Following this reasoning, however, boy who would have to be nominalized also, according to the JG diagram for tree-ness. Although boy * who has a different subtype than tree-ness on a higher order of specificity, the same is true of boy * sick. Objection 1 is inconsistent; counterexamples are available.

Objection 2: Individual versus Class Reference (fig. 14).

The single triad diagram "fails to express the important semantic fact that the sick boy makes reference to both a class of humans (boys) and an individual human. Only the class reference is shown." This is not true. The dominant node is individual reference. Compare the examples adapted

16M 12, 13. We are told on the same page that "this list does not cover all the possibilities."

17M 190.

18M 12.

19 If A has more than one member, then the additional implicit modification required to make the quantifier true reduces A by further intersection down to a unique singleton.

20E 252, 257a.
from Packard's \(^{20}\) and Reichenbach's \(^{21}\) systems. The confusion over dominant versus terminal assignment is what led to objection 2.

**Objection 3**: Adjunctive "levels" of modification.

"Statement and Predicate nodes [in figure 14] are not available to accommodate adverbs . . . [without] making sentence adverbs and manner adverbs appear to be a single class."\(^{22}\) But definitions for placement of sentence versus manner adverbs are ad hoc and circular in reasoning: a modifier comes off the PV because it means manner . . . and it means manner because it comes off the PV. The semantics that determine SX versus PX (or X) level must be handled in the operators themselves or the categories in order to fit the rest of the JG system consistently. PV level, for example, means that the left operand is a PV. How can one operand affect another outside of the junction operation? There are at least two types for each level to choose from, and five for PX alone.\(^{23}\) Either the modifier at B (and its associated delta structure) includes the information for <manner> or it does not. (See figure 15.)

**Alternative 1**: B includes <manner>

Then its left operand, or "level", associates a matching process which is redundant to the system. If a match can take place, then the required information is in the modifier already, making it redundant to place it elsewhere and then require such a match. If on the other hand, as in

**Alternative 2**: B does not include <manner>

then we wonder what a manner adverb such as deliberately is supposed to mean without the <manner> part. If, as we are told, "junction rules can be used to diagram fragments of discourse as well as . . . [complete] sentences"\(^{24}\) the fragments unfortunately and deliberately should also be diagrammable with or without their respective sentence or manner meaning. As it stands, however, those meanings are lost from the adverbs, unless these adverbs are joined to something at a correct "level." A second question is, how is it

\(^{20}\)R footnote on 192 incorporated into Packard's model.

\(^{21}\)M 12.

\(^{22}\)F 85.

\(^{23}\)C 2 on 9.
determined which of the various PX level meanings to assign to the adverbs as we join them? This has not been explained, but is crucial to the issue. Also, if the modifiers are only "suited" to one particular PX sememe choice, the mechanism of signaling or flagging such suitability is comparable to the sememe matching process itself. Either alternative results in an ad hoc process.

Objection 4: Referential Overlap.

JG uses a "proximity principle" (figure 16) to distinguish a relative construction from a complement, as in the ambiguous example the fact that John learned... Focusing on the subjunction triads themselves, we notice that the right operands are already distinctive in category. The structures, then, are sufficiently distinct without a proximity feature. Also, there are constructions for numerous counterexamples for distant topics and antecedents:

See that each neighbor puts a smoke alarm in his house and that he warns his neighbor to do likewise. In case he fails he is not only putting his life in jeopardy... etc.

Also, English passive constructions use a form of distant "overlap" or co-reference (see figure 17).

---

25 Another difference not shown in the abbreviated subtree (designated by the node label plus delta) exists between the two that's. That (relative) is one pro-form, while that (complement) is a sentence article, i.e., Reichenbach's iota-operator. See R 272 and 258. Junction Grammar adopts much the same idea, but is forced to assign entry or recovery to every modifier. Counterexamples such as "the house which I have decided to build" show that the hearer need not have been given identifying information (which I have decided to build) before the the operation. To say that the hearer waited for the relative clause nullifies the difference between that example, and "a house which I have decided to build" (the speaker has not pre-announced his plans). The only difference in the two is that a means there may be more than one, and the means there is not. The clause after the a + house is just as "enterable" or "recoverable" as the same clause is in the example for the.

26 At least those used in JG, and probably nowhere else. It is remarkable that the redundancy of the JG passives are the very counterexample--two inconsistencies in one.
The traditional treatment of relative clauses is to subtype them further as adjectival or adverbial. This would also give sufficient distinction between relative and complement.  

**Objection 5: Order of Operation Processing.**

Here the famous examples are (figure 18):

1. The boys who are poor need money, but the others don't.
2. The boys who are poor need money, but the others don't.

In sentence 1, because of the emphasis on who are poor others means boys other than those who are poor (e.g.: rich boys) or B-W (notice that B is on the left). In sentence 2, because of the emphasis on boys, the others means those who are poor but not boys, (e.g.: poor girls) or W-B. JG tells us that "[intersection] actually won't do, because the order [W-B versus B-W] makes a difference." In other words, subtraction is not commutative. But what do the two remainders B-W and W-B have to do with the intersection? All three are distinct subsets. The JG argument is saying that because subtraction doesn't work, intersection doesn't. That's a non sequitur. Intersection works just fine. Suitable equations are shown in figure 19. B-W = B W' and W-B = B' W. Notice in figure 20 that the correct order of the operands is maintained, with B always on the left. The reference of boys who are poor remains the same throughout.

---

27 Other problems for sentential embedding are the antinomies which result from failure to distinguish between levels of language, as the logicians use the term. In JG, examples like "This sentence is false" come out as meaningful wffses. See Reichenbach, 40.

28 B 22.

29 The actual version of this argument presented in B 21, 22 has additional contradictions which have been removed here for clarity. His discussion of super/subsets contradicts his reference to the commutivity problem in set subtraction. Since it is specifically the subtraction argument that he uses against intersection, we kept that portion in our discussion and corrected the super/subset concept.

30 A logical term for an error in reasoning where a consequent does not follow [Latin], from its unrelated (but often true) antecedent.
always B W. In calculating this phrase only the intersect operator is taken. In computing the value for others however, the result is determined with the not operators taking the complement of any emphasized node/set.

Then there is the possibility that both parts are emphatic, as in 3. Here others3 means rich girls, etc. The current JG method fails here, and the example is missing from their discussion. Another missing example is 4: here others4 means anyone else but boys. Then how can the who node be considered when it does not exist? There is another generalization: Notice that in every case, not operations coincide with emphasis. The inconsistencies associated with the reasoning supporting interjunction hid this fact.

Axiomatic contradictions [transformationality], circular reasoning, and redundancy need to be checked for throughout all of JG. The formalism needs to be completed, definitions made, and most of all, interjunction should be eliminated in favor of intersection. Eliminating the redundancies and extraneous parts means less confusion for the student or translator learning the system, and lower computer bills for the company paying for it.
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APPENDIX -- FIGURES

Fig. 1

DOMINANT NODE ASSIGNMENT

\[(5 + 3) ÷ 2\]

Fig. 2

TERMINAL NODE ASSIGNMENT

\(N\)   \(SV\)

\(N\) ← * \(N\) + \(PVA\)

boy  who  is wearing a hat

ADJUNCTIVE
ENVIRONMENT

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3. **Math Example in format for Relative Clause Example:**

```
            + 2
           /   
          A 4  D 127
         /  
        5   8
```

**Extraneous Environment**

**Additive Environment**

4. **Additional Processing**

```
SV
  +
  /
  WV
  +
  /
  W
  =*
  N
  /
  boy
  +
  N
  /
  who
  +
  PVA
  speaks Russian
```

```
W
```

5. **Relative Clause Example in format for Math Example:**

```
sick boy
    A
    /
    B  n  C
    /
    boy  sick
```

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Figure 6

**INTERJUNCTION:**

\[
Z \rightarrow X \ast Y/D \quad \text{MISSING OPERATION}
\]

\[
\begin{array}{c}
Z \circ D \\
X \ast Y
\end{array}
\]

Figure 7

**PRODUCTION RULES:**

\[
Z \rightarrow XY \\
Z \equiv X \ast Y \\
Z \circ D \equiv Y
\]

Figure 8

\[
G = (V, E) \\
L: V \rightarrow A
\]

Figure 9

**INTERJUNCTION SCHEMATA ARE EQUIVALENT TO INTERSECTION**

\[
\begin{array}{c}
A \\
B \ast C + E
\end{array} \equiv \begin{array}{c}
A \\
B \cap E
\end{array}
\]
x is R-quasi-terminal iff x is R-terminal or for some unique z, z is R-terminal and x is an R-immediate predecessor of z and z is not an R-junction node. (Thus 6, 8, 2, and 1 are R-quasi terminal, but 3 and 5 are not.)

x is R-maximal iff for every z, if zRx then xRz. (Thus 3, 7, and 15 are R-maximal.)

xR-commands y with respect to z, iff for some n, for distinct x₁,...,xₙ
1. z=x₁ and y=xₙ and for some i≤n, x=xⱼ
2. for every i≤n-1, xᵢRxᵢ₊₁ or xᵢ₊₁Rxᵢ, and if xᵢ₊₁Rxᵢ, then xᵢ₊₁ is R-maximal and xᵢ is R-terminal.
(Thus, 5 R-commands 13 with respect to 3 via the chain 3, 5, 6, 12, 13.)

Junction Trees

A system F=(R,f,s,L) is a left-right ordered labelled junction tree iff

1. R is a finite partial ordering that is interconnected, loopless, has only quasi-terminal junction nodes, and only branching non-quasi-terminal nodes. (R is a junction tree.)
2. f is a function from the field of R. (f is the labelling function.)
3. s is R-maximal and L is a strict partial order on the field of R and for every w,x,y,z,x',x'',y',y'' (L is the order relation on R, s is the start node.)
a. if w≠x, and y is an R-immediate predecessor of w, and of x, then wLx or xLw (Thus, 2L5 or 5L2.)
b. if w≠x, and w and x are R-immediate predecessors of y, then wLx or xLw (Thus 12L7 or 7L12.)
c. if w R-commands x,y, and z with respect to s and wRx, y, and z then if xLy and yRz, then xLz and if xLy and xRz, then zLy (Thus if 2L5 then 2L4 and 1L5.)
d. if w is R-terminal and w R-commands x with respect to s, then wLx and if wLx and zRx, and y then xLy. (Thus, if s=3 then 6L13 and 6L11 and if 6L4, then 13L4 and 11L4.)
e. if w is R-terminal and w R-commands x and y with respect to s, and x≠y and x,y are R-maximal and x R-commands x', and x'' with respect to s, and y R-commands y', and y'' with respect to s, and x'L'y', then x'y'. (Thus, if 12L7 then 16L9 and 13L9.)

Def. 2. Let F=(R,f,s,L) be a left-right ordered labelled junction tree.

x is the terminal string of F iff for some n, for some x₁,...,xₙ,
1. for every i≤n-1, xᵢLxᵢ₊₁
2. x₁,...,xₙ are the R-terminal nodes
3. x=(f(x₁),...,f(xₙ)).

Junction Grammars

Def. 3. A structure G=(L,T,J,M,S,P) is a junction grammar iff

1. L is finite (the set of labels)
Figure 11

**ALTERNATIVE #1**

**THE SLASH IS A (SYNTACTO-SEMANTIC) OPERATION**

\[
\begin{align*}
  & A \quad F \quad D \\
  & B \ast C / C + E \\
\end{align*}
\]

\[\ast: (B,C) \to A /: (C,C) \to F +: (C,E) \to D\]

Figure 12

**ALTERNATIVE #2**

**THE SLASH IS NOT A (SYNTACTO-SEMANTIC) OPERATION**

**TWO TREES**

\[
\begin{align*}
  & A \quad / \quad D \\
  & B \ast C / C + E \\
\end{align*}
\]

**BECOME**

\[\text{TREE / TREE} \to \text{TREE SLASH (/) COMBINES TREES}\]

**ONE TREE**

\[
\begin{align*}
  & A \quad D \\
  & B \ast C + E \\
\end{align*}
\]

**TG's DOUBLE-BASE TRANSFORMATION (SEE KOUTSOUDAS, P. 231)**
Figure 13

OBJECTION #1  NOMINALIZATION

sickness

\[ N \]

\[ N \]

\[ N \quad * \quad Adj \]

\[ ness \quad sick \]

sick boy

\[ N \]

\[ N \]

\[ N \quad * \quad Adj \]

\[ boy \quad sick \]

HIGHER ORDER

N

treeness*

\[ N \]

\[ N \]

\[ N \quad * \quad N \]

\[ ness \quad tree \]

boy who

\[ N \]

\[ N \]

\[ N \quad * \quad N \]

\[ boy \quad who \]

HIGHER ORDER

-**

*from Linguistics 501 Materials page 190
Figure 14

**OBJECTION #2: INDIVIDUAL REFERENCE**

\[
<\text{the}> \quad \text{N} \quad \text{INDIVIDUAL REFERENCE}
\]

\[
\text{CLASS REFERENCE} \rightarrow \text{N} \quad \text{* Adj}
\]

\[
\quad \text{boy} \quad \text{sick}
\]

[Figure 4 on page 12 of *Linguistics 501 Materials*]

---

**SOLUTION:**

\[
<\text{the}> \quad \text{N} \quad \text{INDIVIDUAL REFERENCE}
\]

\[
\text{CLASS REFERENCE} \rightarrow \text{N} \quad \text{* Adj}
\]

\[
\quad \text{boy} \quad \text{sick}
\]

---

**Syntax:** \( N + AN \\

**Semantics:** \( N = A \cap N \\

---

**PACKARD**

\( N \)

\[ \text{sick} \quad \text{boy} \]

\[ \frac{\text{A}}{\text{sick}} \quad \frac{\text{N}}{\text{boy}} \]

---

**REICHENBACH**

\[ F = D_f \{ x | f(x) \} \]

\[ f \in F \]

\[ f \cap N = F \cap N \]

---

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Figure 15

**OBJECTION #3: ADJUNCTIVE LEVELS**

<table>
<thead>
<tr>
<th>X</th>
<th>PX</th>
<th>SX</th>
</tr>
</thead>
<tbody>
<tr>
<td>-motion, destination, source, to where, from whence</td>
<td>-time, when</td>
<td>-speaker's, attitude, opinion</td>
</tr>
<tr>
<td>-indirect objects to whom, to what</td>
<td>-manner, how</td>
<td>-vocatives, nouns of address</td>
</tr>
<tr>
<td>-adverb particles</td>
<td>-static location, at where</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-reason, why</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-degree, how much</td>
<td></td>
</tr>
</tbody>
</table>

**PV-level operation**

A

\[
\text{PV-level operation means that the left operand is a} \quad \text{PV} \quad \ast \quad \text{B} \quad <\text{manner}> \quad \text{(or flag for it)}
\]

**How do we choose?**

1. **B includes** <manner>
   
   Then we have a redundant matching process with the "PV level"
   
   "Level system" is then *ad hoc*.

2. **B does not include** <manner>
   
   *deliberately* - <manner> = ? How do we diagram these fragments?
   
   How is a selection made from the list of five possibilities?
   
   Any signal or flag at B is homomorphic to the process in alternative #1.
Figure 16

OBJECTION #4 REFERENTIAL OVERLAP: THE PROXIMITY PRINCIPLE

The fact that John learned... Ambiguity

RELATIVE

COMPLEMENT

Different right operands already distinctive

COUNTEREXAMPLE

See that each neighbor puts a smoke alarm in his house and that he warns his neighbor to do likewise. In case he fails he is not only putting his life in jeopardy...

TRADITIONAL GRAMMAR:

ADJECTIVE CLAUSE (RELATIVE)

NOUN CLAUSE (COMPLEMENT)
It is believed by many people that colds have been discovered to be cured by Vitamin C.

Distant "overlap"
(co-reference)
OBSESSION #5  ORDER OF PROCESSING INTERJUNCTION

1. The boys who are poor need money, but the others don't.
2. The boys who are poor need money, but the others don't.

1. boys who are poor

2. boys who are poor

Others₁ = B-W
(e.g.: rich boys)

Others₂ = W-B
(e.g.: poor girls)

B: all Boys
W: all Who are poor
B-W: all Boys minus all Who are poor
W-B: all Who are poor minus all Boys
B∩W: all Boys Who are poor (regardless of emphasis)

3 DISTINCT SUBSETS
B-W ≠ W-B
B ∩ W

Set subtraction is NOT commutative

Intersection set is distinct from either subtraction set
Figure 19

SET THEORY EQUIVALENCES SHOWN WITH THE VENN DIAGRAM

1. \( B - W = B \cap W' \)

2. \( W - B = B' \cap W \)
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Figure 20

OPERATION ('') CORRESPONDS WITH EMPHASIS (')

1. The boys who are poor need money, but the others₁ don't.

   \[ B \quad W' \quad \text{OTHERS}_1 \subseteq B \cap W' \]

   (rich boys)

2. The boys who are poor need money, but the others₂ don't.

   \[ B' \quad W \quad \text{OTHERS}_2 \subseteq B' \cap W \]

   (poor girls, poor men)

3. The boys who are poor need money, but the others₃ don't.

   \[ B' \quad W' \quad \text{OTHERS}_3 \subseteq B' \cap W' \]

   (rich men, poor girls)

4. The boys need money, but the others₄ don't.

   \[ B' \quad \text{OTHERS}_4 \subseteq B' \]

   (men, girls, women)

Reference (dominant node) for boys who are poor is always \( B \cap W \)

Reference for othersₙ includes the not operator ('')

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"Sick boy" Comparison
(Each tree is reversed for effect)

PROPOSAL:

THROUGHOUT JG, EXCHANGE

Current JG interjunction:

6 nodes

\[
\begin{tikzpicture}
  \node (SA) {SA} at (0,0) ;
  \node (N) {N} at (1,0) ;
  \node (PA) {PA} at (-1,-.5) ;
  \node (a) {A} at (-1,-1) ;
  \node (n) {n} at (0,-1) ;
  \node (N1) {N} at (1,-1) ;

  \draw (PA) -- (a) ;
  \draw (a) -- (n) ;
  \draw (n) -- (N1) ;
  \draw (PA) -- (N) ;
\end{tikzpicture}
\]

3 operators

\[PA + N * N + A\]

boy

sick

FOR

Same structure with errors removed:

3 nodes

\[
\begin{tikzpicture}
  \node (N) {N} at (0,0) ;
  \node (a) {A} at (-.5,-.5) ;
  \node (n) {n} at (0,-.5) ;
  \node (N1) {N} at (.5,-.5) ;

  \draw (a) -- (n) ;
  \draw (n) -- (N1) ;
\end{tikzpicture}
\]

1 operator

\[A n N\]

sick boy

PLUS:

Check all junctions for similar errors in formulation
Check entire grammar for contradiction and inconsistency
<table>
<thead>
<tr>
<th>Reference</th>
<th>Source in Footnotes</th>
</tr>
</thead>
</table>