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Generalized Phrase merely bound as a mention is made of
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ves with its antecedent dering to morphophone (pronominal). That is,
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ON DERIVING THE WELL-
FORMEDNESS CONDITION
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One of the cornerstones of early autosegmental theory was the
Well-Formedness Condition on autosegmental representations.
Goldsmith (1976) formulated it as in (1).

(1) Well-Formedness Condition (WFC)
   a. All vowels are associated with at least one tone;
   b. Association lines do not cross.

Subsequent research has shown that (1) is too strong. Following
Pulleyblank (1983), I assume a weaker form of the WFC in (2).

(2) No-Crossing Constraint (NCC)
   Association lines do not cross.

Goldsmith (1976) formalizes the WFC in terms of a notion of
“connectedness.” In light of the weakening of the WFC to
the NCC, a new formalization is necessary, since the old one
in terms of connectedness excludes violations of (1a) that are
not excluded by the NCC. Here, I argue for a conception of
association where autosegments are seen as issuing articulatory
instructions to the slots or nodes they are linked to. This view,
coupled with a natural interpretation of linear ordering on a tier,
allows us to derive the NCC while allowing violations of (1a).

This squib is organized as follows. I begin by reviewing
Sageye’s (1986) demonstration of the paradoxicality of associ-

Thanks to D. Archaeology, E. Moravcsik, D. Pulleyblank, E. Sageye,
and two anonymous reviewers for much useful feedback. This work
builds on material first developed in Sageye (1986) and extended in Sageye
ation viewed in terms of simultaneity. I then show how my proposal avoids both these paradoxes and certain problems facing Sagey’s solution.

Sagey suggests that linear order of elements on a tier encodes temporal precedence. The properties of that ordering “need not be defined in [Universal Grammar], because they are part of our knowledge of the world” (p. 285). The properties Sagey assumes are transitivity, antisymmetry, and irreflexivity. She defines these as follows (p. 285).

(3) Temporal Precedence (“<”)
   a. Transitivity: if A < B and B < C, then A < C
   b. Antisymmetry: if A < B, then NOT B < A
   c. Irreflexivity: NOT A < A

Sagey shows that paradoxes result if association lines are interpreted as indicating simultaneity. Simultaneity, she assumes, has the following properties (p. 286).

(4) Simultaneity (“=”)
   a. Transitivity: if A = B and B = C, then A = C
   b. Symmetry: if A = B, then B = A
   c. Reflexivity: A = A
   d. Substitution: if A = B and B < C, then A < C

Sagey presents three paradoxes. Consider first the representation in (5).

\[ \begin{array}{c}
  x \\
  \hline
  F \\
  \hline
  G \\
\end{array} \]

Assume that F and G are distinct melodic elements linked to the same timing unit on the skeletal tier. From the ordering of elements on the melodic tier, it follows that F precedes G (F < G). From the simultaneity interpretation of association lines, it follows that F is simultaneous with x (F = x) and G is simultaneous with x (G = x). From these three propositions and substitution, it follows that x precedes x (x < x), which contradicts (3c).

A second paradox can be constructed from (5) as well. By symmetry, x = F follows from F = x. By transitivity, G = F follows from G = x and x = F. This contradicts the fact that F precedes G (F < G).

A third paradox can be shown to arise from discontinuous linking, as in Semitic morphology (McCarthy 1979). Consider the representation in (6).

\[ \begin{array}{c}
  x_1 \\
  \hline
  x_2 \\
  \hline
  x_3 \\
  \hline
  F \\
\end{array} \]

On the skeletal tier linear precedence gives x₁ < x₂ and x₂ < x₃. From the simultaneity interpretation of association, it fol-
I then show how my certain problems face elements on a tier entries of that ordering nmr], because they are 285. The properties entry, and irreflexivity.

1. $B < C$, then $A < C$
2. $\text{NOT } B < A$
3. Association lines are simultaneity, she asks.
4. $B = C$, then $A = C$
5. $B = A$
6. $B < C$, then $A < C$

Consider first the replication

elements linked to from the ordering of at $F$ precedes $G$ ($F$ of association lines, $F = x$) and $G$ is since propositions and $(x < x)$, which confirm from (5) as well. By transitivity, $G = F$ radiates the fact that from discontinuous ity (1979]). Consider

$s_{1} < x_{2}$ and $x_{2} <$

association, it follows that $F = x_{1}$ and $F = x_{2}$. By substitution on $s_{1} < s_{2}, F < s_{2}$ follows. From $x_{2} < x_{3}, \text{NOT } x_{3} < x_{2}$ follows by antisymmetry. Finally, by substitution, $\text{NOT } F < x_{3}$ follows from $\text{NOT } x_{3} < x_{2}$, a logical contradiction with respect to $F < x_{3}$.

To deal with these paradoxes, I depart from Sager’s view and propose that association encodes a different relation than contemporaneity. If association lines are instead interpreted as issuing an articulatory instruction to the slot or node, the paradoxes above can be avoided straightforwardly.

If this is assumed, then many of the properties in (4) are simply inapplicable to association. For example, symmetry (4b) says that if $A$ is simultaneous with $B$ ($A = B$), then $B$ is simultaneous with $A$ ($B = A$). If an autosegment is conceived of as issuing instructions to a slot, the slot does not issue instructions to the autosegment. Hence, association is asymmetric. Reflexivity (4c) would say that an autosegment issues articulatory instructions to itself. This is nonsensical; hence, association is irreflexive. Finally, substitution would say that if an autosegment issues instructions to a slot and the slot precedes a second slot, then the autosegment precedes that second slot. This is also nonsensical; hence, association does not exhibit substitutivity. Finally, there is transitivity, which does appear to hold of association. For example, if an autosegment issues instructions to a node that is issuing instructions to a timing slot, then it seems reasonable to say that the autosegment is issuing instructions (indirectly) to the timing slot.

This all results in a set of properties identical to the similarly asymmetric temporal precedence relation,

(7) 

\text{Association ("\Rightarrow")}

a. Transitivity: \[ \text{if } F \Rightarrow G \text{ and } G \Rightarrow x, \text{ then } F \Rightarrow x \]

b. Antisymmetry: \[ \text{if } F \Rightarrow G, \text{ then } \text{NOT } G \Rightarrow F \]

c. Irreflexivity: \[ \text{NOT } F \Rightarrow F \]

If association has this set of properties, then none of the simultaneity paradoxes apply. This is because these paradoxes rest on certain properties of simultaneity not exhibited by association: substitution and symmetry.

The first paradox of (5) rested crucially on the substitutability of association. Association in (7) is no longer substitutable. The second paradox of (5) relied on symmetry, and association in (7) is asymmetric. Last, the paradox in (6) also relied on substitution, which is no longer a property of association (7).

This interpretation of association has the additional consequence of allowing us to derive the NCC as a consequence of the following natural assumption.\(^1\)

\(^1\) Thanks to an anonymous reviewer for pointing this out to me.
(8) Ordering Principle

Given two autosegments on a single tier, A then B, instruction B cannot be issued before instruction A.

In a configuration (9), which would violate the NCC, the realization of B on \( x_2 \) would precede the realization of A on \( x_1 \).

\[
\begin{array}{c}
A & B \\
\hline
x_1 & x_2
\end{array}
\]

Principle (8) is, in effect, the residue of substitutability, but it avoids the paradoxes stated above while simultaneously providing a rationale for the NCC.

Sagey offers an alternative solution to the paradoxes by replacing simultaneity with overlap. Thus, a representation like (10) does not imply that \( F \) and \( x \) are simultaneous \((F = x)\). Rather, it is interpreted to imply that "at least one instant of time be shared between the feature and the x-slot. When \( F \) overlaps \( x \), that means that at least one point \( P(F) \) in \( F \) and one point \( P(x) \) in \( x \) are simultaneous" (p. 250). Sagey diagrams this relationship as in (11).

\[
\begin{array}{c}
X \\
\hline
F
\end{array}
\]

Elements linked by association lines must therefore be interpreted as (line) segments of time where the association line connects at least one point in that segment.

Sagey shows how this interpretation of association lines allows her to avoid the above contradictions. Consider, for example, the paradoxes associated with (5). These disappear when (5) is replaced with (12).

\[
\begin{array}{c}
F & \quad X \\
\hline
G
\end{array}
\]

From the melody tier it follows that all points of \( F \) precede all points of \( G \) (All \( P(F) < all \ P(G) \)). From the association lines it follows that some point of \( F \) is simultaneous with some point of \( x \) (Some \( P(F) = some \ P(x) \)) and that some point of \( G \) is simultaneous with some point of \( x \) (Some \( P(G) = some \ P(x) \)). Invoking substitution allows us to conclude that some point of \( x \) precedes some point of \( x \) (Some \( P(x) < some \ P(x) \)). This is now entirely consistent with the interpretation of \( x \) as a line segment.
The second contradiction resulted from symmetry and transitivity. Transitivity is inapplicable now because the points that are multiply linked to melody units are not (necessarily) the same point. Hence, transitivity will not allow us to establish any overlap between F and G, the source of the paradox.

The paradox associated with (6) is avoided because the contradiction NOT F < x₁ and F < x₂ is reduced to the claim that some point of F does not precede x₁ (NOT some P(F) < all P(x₁)) and some point of F does precede x₁ (Some P(F) < all P(x₂)). Since F contains more than one point, no paradox is entailed.

Under this proposal the NCC can be derived, as well: crossed lines create a paradox. In (9) x₁ precedes x₂ (All P(x₁) < all P(x₂)) and A precedes B (All P(A) < all P(B)). From association, A overlaps x₂ (Some P(A) = some P(x₂)). Substitution on all P(x₁) < all P(x₂) results in Some P(B) < some P(A), which contradicts All P(A) < all P(B) (p. 294).

Sagey claims that "the points of time within a feature or x-slot are accessible only at the late level of phonetic implementation, where quantitative rules may apply . . . they are not manipulable or accessible by phonological rules" (p. 293). Interpreted literally, this would seem to imply (contrary to our assumption above) that phonologically these elements are points rather than line segments. This is impossible, however. The simultaneity paradoxes arise in the phonology and the NCC must hold in the phonology. Therefore, in order for overlap to produce the results intended, the elements must contain more than one point in the phonology; hence, they would have to be line segments in the phonology.

This results in a number of problems for this solution. First, in principle, it permits one to vary the length of the segments in the phonology. This would multiply the number of ways phonological length could be represented. Second, in principle, the degree of overlap could be manipulated phonologically. This would result, for example, in a potentially infinite number of contrasting contour segments in the phonology.

Third, this view makes indeterminate claims concerning multiple tiers. Consider, for example, a situation such as the one shown in (13). Here there is an autosegmental tier (H and I) linked to the timing slots (x₁, x₂, and x₃) through another tier (F and G). This sort of situation arises in segmental feature geometry (Steriade (1982), Clements (1985), and Sagey (1986)).
Presumably, such a representation would be interpreted as follows.

\[(14) \quad X_1 \quad X_2 \quad X_3 \]
\[F \quad \quad \quad \quad G \]
\[H \quad I \]

Such a structure gives rise to several related problems. First, what features percolate down to the timing slots? For example, \(x_1\) is linked to some point of \(F\) that is linked to nothing on the second tier. Points on \(G\) are linked to points on \(H\) and \(I\), but neither of these points is linked to \(x_3\).

A second problem with (14) is the relative order of linked points in \(F\) or \(G\). The following are all legitimate, but it is unclear whether they have empirical consequences.

\[(15) \quad F \quad \quad F \quad \quad F \]

Given these indeterminacies in the overlap solution, I conclude that the analysis in terms of issuing instructions is to be preferred.\(^2\)

References


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\(^2\) Under any conception, it is unclear what should be said if, in (13), \(G\) is also linked to \(x_2\). How is the contour value \(H-I\) to be transferred to the slots \(x_2-x_3\)?