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AMERICAN SIGN LANGUAGE AND THE
ARCHITECTURE OF PHONOLOGICAL THEORY*

1. GOALS

Of the predictions a linguistic theory makes, the most interesting are those that follow from the 'architecture' of the theory – from the way the theory is constructed rather than from additional stipulations. In the architecture of generative grammatical theory, the phonological component provides a phonetic interpretation of the strings of formatives in surface structures (Chomsky and Halle, 1968). The chief source of the formatives in surface structure is the lexicon, which provides the lexical items that are inserted into deep structures. The syntactic component converts these deep structures into surface structures, which are interpreted by the phonological component. Ignoring semantics, morphology, etc., we can represent the relation between the lexicon and the phonology as in (1):

(1)   Lexicon→ Syntax→ Phonology

The lexicon feeds the syntactic component, which in turn feeds the phonological component. If we ignore the role of the syntactic component in providing the surface structures on which the phonological component operates, the relation of the lexical and phonological components can be represented as (2):

(2)   Lexicon→ Phonology

The phonological component operates on the phonological matrices of the lexical items provided by the lexicon. This follows from the architecture of the theory.

The model in (2) brings out what (1) predicts about the relation between rules in the lexical and phonological components. With no further stipulations, the architecture of the theory predicts:

(3)   Lexical rules feed each other, phonological rules feed each other, lexical rules feed phonological rules, but phonological rules cannot feed lexical rules.

This theory was developed entirely on the basis of data from oral languages. The question arises as to whether it is also an adequate theory of rule interaction for sign languages, or whether their grammars are constructed on different principles. In this paper we focus on the predictions the theory makes about American Sign Language (ASL), the language of Deaf communities in the United States and most of Canada. Our chief goal is to show that the architecture of the theory makes correct predictions about rule interaction in ASL, providing a genuine explanation of the data.

The theory's claim to explanation in this case rests on its claim that some rules are in the lexicon while others are in the phonology. We adopt the traditional assumption that rules of derivational morphology are in the lexicon. They involve not just phonological matrices, but triples of semantic, syntactic, and phonological representations. They are thus formally distinct from phonological rules affecting only phonological matrices, which we assign to the phonological component. Whether a rule is in the lexicon or the phonology is thus predictable from its formal properties.

A theory of lexical phonology has recently been developed by Kiparsky (1982, 1983, 1984, 1986), Mohanan (1985), Halle and Mohanan (1986), Pulleyblank (1986), and others. This theory departs from the model in (2) in that some phonological rules apply cyclically in the lexicon, where they are interspersed with the rules of derivational morphology. Other phonological rules apply to the output of the lexicon. The key difference between lexical phonology and the model in (2) is that in the former some phonological rules apply in the ASL lexicon. Since we have not found evidence for phonological rules in the ASL lexicon, we have not posited them. Crucially, lexical phonology and the model in (2) have the same architecture insofar as both posit a class of phonological rules that apply to the output of the lexicon. That is what is relevant here.

The architecture of the model in (2) predicts the rule interactions in (3). We will show that these predictions are confirmed for ASL, concluding that the architecture of the theory provides a principled explanation of why ASL rules interact as they do.

We begin with three rules of derivational morphology that have been discussed in the ASL literature, showing that derivational rules can apply to each other's outputs as predicted. We then present two phonological rules – Weak Drop and Weak Freeze – showing that two further predictions in (3) are confirmed: derivational rules feed phonological rules and phonological rules feed each other. Finally, we argue for a post-lexical phonological component by showing that the output of a derivational phonological rule must be prevented from undergoing a derivational phonological rule. With the phonological rule in a post-lexical phonological component and the derivational rule in the lexicon, this follows automatically from the architecture of the model in (2).

For each rule we make explicit the relevant phonological properties of the class of signs that undergo it and the phonological change(s) it effects. This enables us to construct arguments for rule interaction that are independent of whatever formalism may be adopted for ASL phonology.

2. PHONOLOGICAL PRELIMINARIES

2.1. Phonological Structure in ASL

In recent years, researchers have asked to what extent the notions used to describe oral language phonologies are relevant for the description of sign languages. Many have claimed that a basic difference between oral and signed languages is that oral languages have segmental structure, while signs are simultaneous realizations of phonological feature bundles (Battison, 1974; Klima, 1975; Friedman, 1977; Klima, et al., 1979; Wilbur, 1979; Studdert-Kennedy and Lane, 1980; Siple, 1982). Recently, however, researchers of oral languages have found evidence for simultaneously occurring tiers of phonological elements (autosegmental phonology), while researchers of signed languages have found evidence for segmental structure in ASL. Newkirk (1981) argues that movement in ASL signs exhibits a sequential-segmental organization. Supalla (1982) analyzes movement in a major class of ASL verbs as combinations, some sequential and some simultaneous, of one or more of seven basic movement primitives. Liddell (1984a) argues that ASL signs are to be analyzed as sequences of movement (M) and hold (H) segments. Liddell (1984b) Johnson and Liddell (1984) and Liddell and Johnson (1984, 1986a, 1986b) propose autosegmental representations in which movement is represented on segmental tiers for the strong and weak hands, with which bundles of handshape, location, orientation, and

non-manual features are associated by autosegmental attachment rules. For two-handed signs, the strong and weak hand segmental skeletons are each associated with such a feature bundle. Sandler (1986a, 1986b) likewise proposes segmental tiers, but unlike Liddell and Johnson, she proposes that the segments are movements (M) and locations (L), and that "hold" is a specification of location (L). In addition, her analysis differs from the Liddell-Johnson analysis in that handshape is not included in the same tier with other elements, but isolated as a separate tier. Wilbur (1982, 1984, 1985, 1986) and Coulter (1986a, 1986b) have approached the issue of sequential structure from another direction, arguing for syllable structure in ASL. While it is clear that ASL has sequential phonological structure, basic issues concerning phonological representations are still topics of debate. The crucial issues concern how many tiers are needed and which features are represented on which tiers. Our goal here is not to offer evidence for one analysis over another, but rather to show the comparability of oral and sign language phonologies with respect to the interaction of phonological rules and rules of derivational morphology. Because the segmental representations proposed to date do not adequately represent certain types of signs that play a crucial role in our arguments, we formulate our arguments in terms independent of a particular phonological representation. Some issues concerning representations are discussed in the Appendix.

### 2.2. One-handed versus Two-handed Signs

Any introduction to signed languages will note that some signs are made with one hand and some with two. Whether a sign is made with the right or left hand is never distinctive in ASL. Right-handed signers make one-handed signs with the right hand, left-handed signers with the left. This hand, sometimes called the "dominant" hand in the literature, we call the "strong" hand; the other we call "weak". Except under discourse conditions not relevant here, one-handed signs are made with the strong hand.
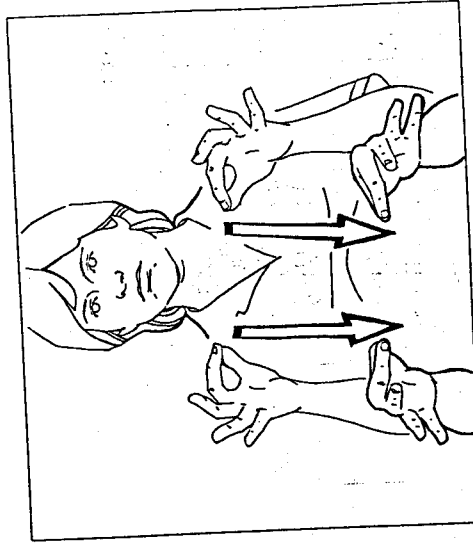
2.3. Alternating Signs

A class of signs that figure prominently in our argument are ALTERNATING signs – signs in which the hands alternate in movement. Signs that satisfy this definition are necessarily two-handed. The sign ACT (4) illustrates this class: first the strong hand moves, then the weak hand follows in the same direction, then the strong hand repeats its initial

movement. ACT thus contrasts with DECIDE (5), where the hands move simultaneously in the same direction.
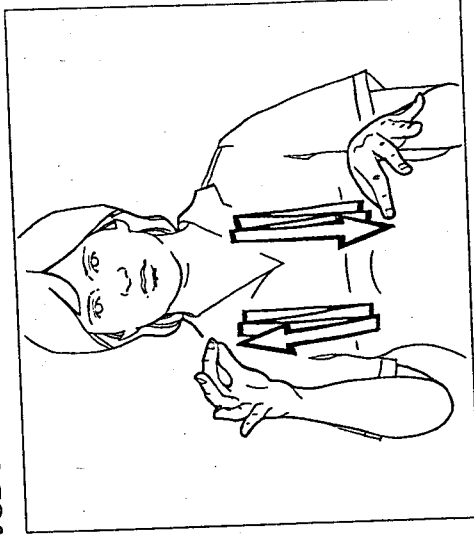
(4) ACT
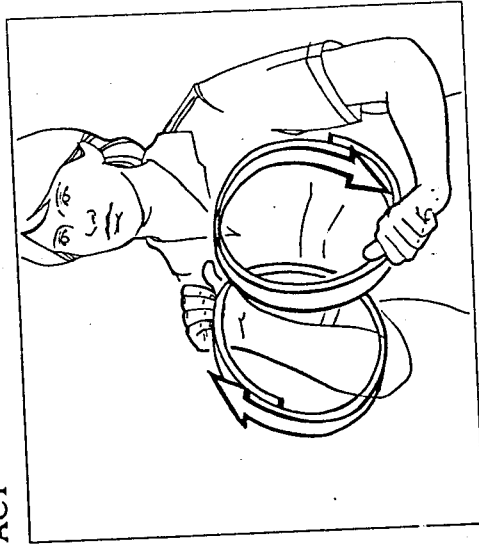
(5) DECIDE

The nature of alternating signs can be seen more clearly in signs that involve a change in handshape. The key point is that in signs which involve both movement and handshape change, the two occur at the same time. For example, in the non-alternating sign BAWL-OUT (6), the two hands move and change handshape simultaneously. In alternating signs with handshape change, the fact that the two hands move ing signs with handshape change, the fact that they change handshape successively can be seen in the fact that they change handshape suc-

cessively – first one and then the other. Thus, in the alternating sign MILK (7), the handshape changes from open to closed fist as the strong hand moves downward, then the same change is executed by the weak hand as it moves in the same direction, finally by the strong hand as it executes the third movement. The hands alternate not only downward movement in sequence, but handshape change as well.

(6)   BAWL-OUT
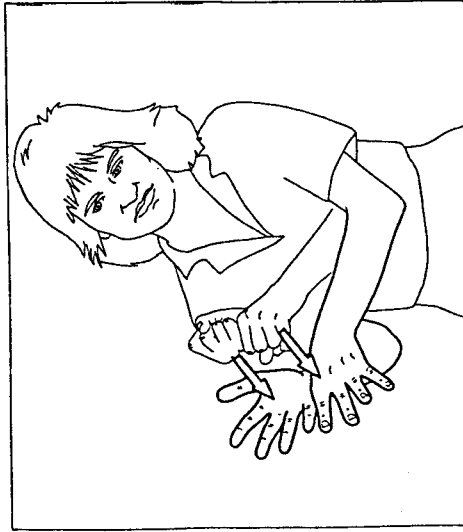
(7)   MILK (verb)

There is another class of signs we classify as alternating: those in which the hands move back and forth, moving in opposite directions at the same time. Unlike ACT, SCIENCE, CLIMB, MILK and CRY, where the

hands alternate movement is sequence, in signs like JUDGE (8), EXPLAIN, TRAFFIC, COMPETE, PROBLEM, RAP, TALK, COMMUNICATE, INTERPRET, DRIVE, the hands alternate back-and-forth movement simultaneously. In JUDGE, the hands alternate up and down movements. First the strong hand moves down while the weak hand moves up, then as the strong hand moves up, the weak hand moves down.

(8)   JUDGE

Supalla and Newport (1978) characterize movement in non-alternating signs as either UNIDIRECTIONAL (movement in only one direction) or BIDIRECTIONAL (movement back and forth with no intervening hold). This distinction can be extended to the alternating signs. JUDGE is bidirectional; it consists of two bidirectional movements (down and up). ACT and MILK, on the other hand, are unidirectional, consisting of successive unidirectional (downward) movements by each hand. There is a systematic contrast between bidirectional and unidirectional alternating signs. In bidirectional alternating signs, the hands move in opposite directions at the same time, beginning movement at the same time. In unidirectional alternating signs, the hands move successively, the strong hand moving first.

Because bidirectional alternating signs have a back-and-forth movement, each movement begins and ends at the same point. In unidirectional alternating signs, however, each hand executes a single directional alternating signs. movement in one direction. The initial and terminal points of each hand's movement are therefore different.

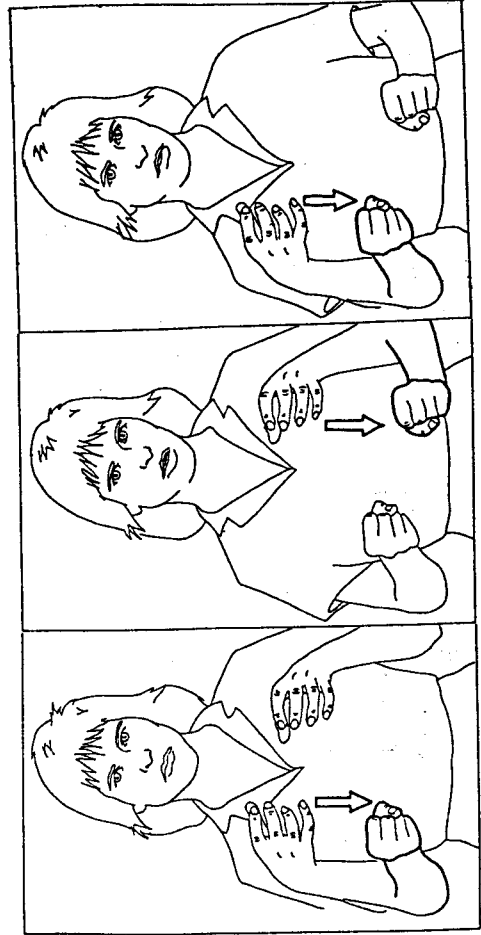This distinction is obscured by the fact that in unidirectional alternat-

ing signs, after the first execution of the unidirectional movement the strong hand returns to the initial point to begin the second execution. This looks like the return movement in bidirectional signs, but it is only a transition to the initial point to begin the second execution. The difference between unidirectional and bidirectional alternating signs appears clearly at the end of the second execution: in bidirectional alternating signs the hands end up at their initial point; in unidirectional ones, however, the initial and terminal points are different.

Another contrast between unidirectional and bidirectional alternating signs can be seen in the number of movements required to perform the basic reduplicated form of the sign. In signs like JUDGE (8) with bidirectional alternating movement, each hand completes *two* back-and-forth movements. In signs like ACT (4) and MILK (7) with unidirectional movement, first the strong hand moves in one direction, then the weak hand moves while the strong hand returns to its initial point, and finally the strong hand repeats its first movement. There are only three unidirectional movements in such a sign.

In all alternating signs, the strong hand moves twice. The hands never move in the same direction at the same time.

There are other signs in which a unidirectional movement is performed first by one hand and then the other, e.g., JESUS, CRUCIFY, GLOVES, and HANDS. These differ from alternating signs in three ways.

First, in signs like JESUS, the strong hand moves to make contact with a stationary weak hand, then dominance is 'reversed', with the weak hand performing the same movement on the strong hand. Similarly in CRUCIFY, first the strong hand contacts a stationary weak hand, then the weak hand assumes the movement and handshape of the strong hand and makes contact with the strong hand, which now is stationary. In alternating signs, a moving hand never makes contact with a stationary hand; if the hands make contact at all, as in DOESN'T-MATTER, both are moving.

Second, the number of movements in signs like JESUS and CRUCIFY shows they are not alternating signs. In unidirectional alternating signs, e.g., ACT and MILK, there are three unidirectional movements. But in JESUS and CRUCIFY, there are only two movements: one as the strong hand contacts the weak, and then a second as the weak hand contacts the strong.

Third, forms like JESUS, CRUCIFY, GLOVES are never the output of rules which make input forms alternating. For example, in the Characteristic Adjective Rule which we discuss in section 3.2, one-handed signs become alternating, but outputs of this rule do not exhibit the properties of signs like JESUS.

3. RULES OF DERIVATIONAL MORPHOLOGY

Both traditional and modern grammars of oral languages discuss the ways lexical items are derived from stems and other lexical items. Such insights are captured by means of rules of derivational morphology, which we illustrate here. We then show that these rules feed each other and phonological rules as well.

3.1. *Activity Noun Rule*

Activity nouns are described by Klima et al. (1979) as forms which carry the meaning of 'the general activity of (verb)'. Such verb-noun pairs in ASL include ACT (verb) and ACTING (activity noun), SWIM and SWIMMING, WRITE and WRITING, CHANGE and CHANGING, WALK and WALKING, CHAT and CHATTING, SURVEY and SURVEYING. In these pairs, the two forms are alike with respect to handshape, orientation, and location but they differ in manner of movement.

Activity nouns have numerous repeated small, quick movements made with tensed musculature.[1] Such tense movement repeated numerous times (small, quick, stiff movements) we call TRILLED. For example, the activity noun ACTING (9) has trilled movement, but its related form ACT (4) has only three unidirectional movements which are larger in comparison and not tense. (The smaller movement is shown by a smaller arrow in (9).)

(9)   ACTING
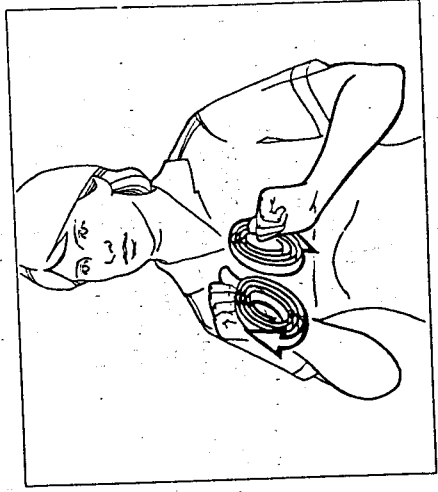
[1] Supalla and Newport (1978) discuss such movements with respect to another derivational rule, as well as tense movements not repeated numerous times that are not relevant here.

To derive activity nouns from verbs, the grammar of ASL will need a derivational rule that takes non-stative verb forms as inputs and yields outputs that are nouns with the activity noun meaning and whose phonological representations are marked as trilled. This can be stated schematically:

(10) *Activity Noun Rule*
      Input: Non-stative verb
      Phonological change in output: Trilled movement

This statement is an informal version of a rule that must refer to triples of semantic, syntactic and phonological representations. It indicates only the phonological change, since other aspects are not relevant.

3.2. *Characteristic Adjective Rule*

Initially described by Klima et al. (1979), characteristic adjectives have the meaning 'characteristically (adjective)'. They can be derived only from adjectives indicating incidental or temporary states, not from those referring to an inherent state, e.g., TALL, SHORT, UGLY, BLONDE. Since there is no English form with the meaning of characteristic adjectives, we will use a variety of glosses, e.g., CHARACTERIS-TICALLY-FOOLISH/JOKESTER, CHARACTERISTICALLY-SUSPICIOUS/PARANOID, CHARACTERISTICALLY-QUIET/TACITURN, CHARACTERISTICALLY-SICK/SICKLY CHARAC-TERISTICALLY-MISCHIEVOUS/HOLY-TERROR, CHARAC-TERISTICALLY-WRONG/ERROR-PRONE.

Nearly all characteristic adjectives have circular movement and are two-handed.[2] All are reduplicated. They divide into two classes according to whether the two hands move together, as in TACITURN (14) and SICKLY, or in alternating fashion, as in FLEXIBLE (12), ERROR-PRONE and PARANOID. At first it might seem necessary to list which characteristic adjectives are alternating and which are not. However, this is predictable: only one-handed adjectives have alternating characteristic adjective forms. UNDERSTANDING (11) is alternating. In contrast, two-handed basic forms, e.g., QUIET, (13) have non-alternating characteristic adjectives (14):

[2] A few characteristic adjective forms are two-handed but not circular, e.g., AFRAID/FEARFUL, COLD/REMOTE. All of these forms are bidirectional. Perhaps the fact that they are not circular is due to the fact that they are bidirectional.
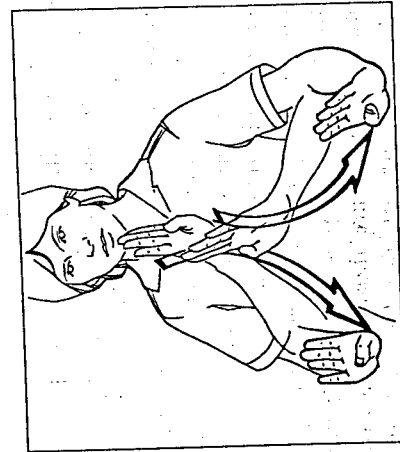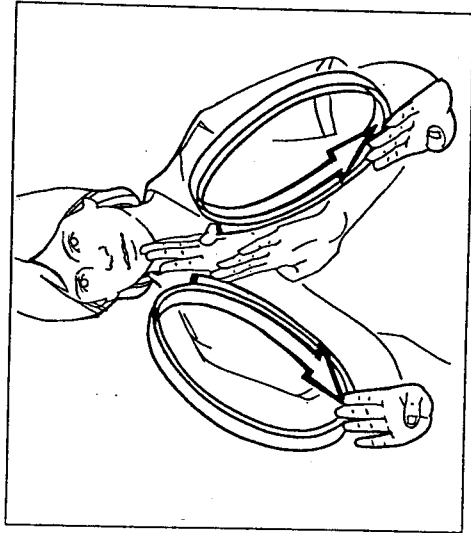
(11) UNDERSTANDING

(12) FLEXIBLE
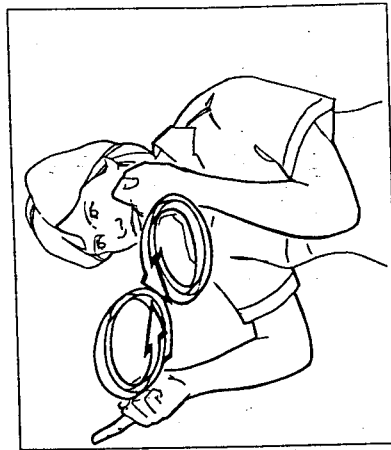
(13) QUIET

(14)   TACITURN

(15)   *Characteristic Adjective Rule*
    Input: Adjective

    Phonological change
    in output: Reduplicated circular movement
                                  If input is one-handed, output is alternating.

The rule does not specify that the output is two-handed. If the input form is two-handed, so is the output form. If the input form is one-handed, the output is alternating, which is two-handed by definition. For this reason, we have not specified 'two-handed' as a phonological change in (15).

There is some evidence for this treatment. A handful of one-handed adjectives do not have alternating characteristic adjectives. These are signs in which the hand makes contact with the opposite (contralateral) side of the body. If the corresponding contralateral characteristic adjectives were alternating, the movement of the hands would alternate, each touching the opposite side of the body. But such contralateral alternating signs are impossible in ASL. Consequently, the characteristic adjective (e.g., GUILT-RIDDEN) of a contralateral adjective such as GUILTY cannot be alternating. It has circular movement, as predicted, but it is one-handed. If (15) specified 'two-handed' as a phonological change in the output, all characteristic adjectives would be predicted to be two-handed, but they are not. The only one-handed adjectives whose characteristic adjectives are two-handed are those that are two-handed by virtue of being alternating. This supports our decision not to specify

'two-handed' as a phonological change in (15), letting two-handedness follow as a consequence where signs become alternating.

3.3. *ISH Adjective Rule*

Bellugi (1980) identifies a set of derived adjectives with the meaning of '(adjective)-ish', e.g., YOUNG and YOUNGISH, CHINESE and CHINESE-ISH ('oriental'), OLD and OLDISH, BLUE and BLUISH. While the basic adjectives vary in manner of movement, the ISH forms are trilled (repeated tense movements). For example, OLD has a single movement, but its ISH forms OLDISH (17) is trilled.

(16)   OLD

(17)   OLDISH

(18)   *ISH Rule*
       Input: Adjective
       Phonological change in output: Trilled movement

3.4. *Interaction of Derivational Rules*

In a theory with sequential rule application, the architecture of the model in (2) predicts that (in the absence of constraints specifically blocking such interaction) rules of derivational morphology will feed each other. This is correct. We illustrate this with the ISH Adjective Rule (18) and the Characteristic Adjective Rule (15).
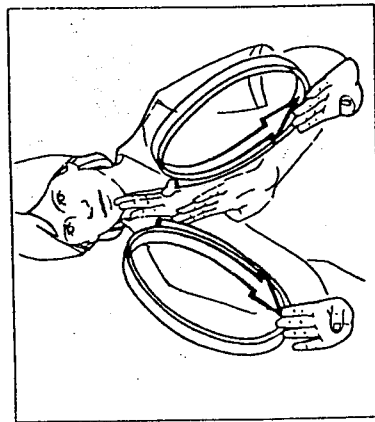
Application of ISH (18) to QUIET (13) produces QUIETISH (19), which is trilled. Application of the Characteristic Adjective Rule (15) to QUIET (13) produces a sign meaning CHARACTERISTICALLY-QUIET or TACITURN (20), with circular movement.
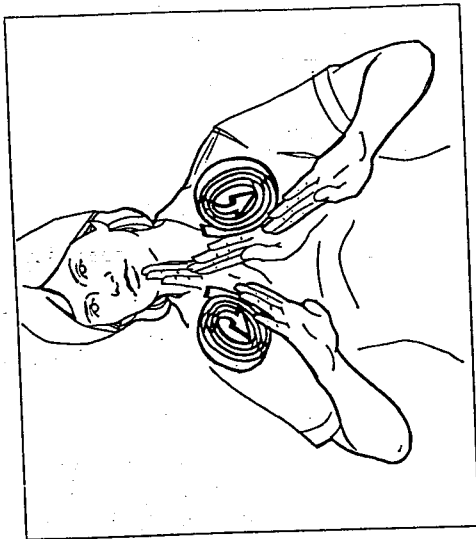
(19)   QUIETISH
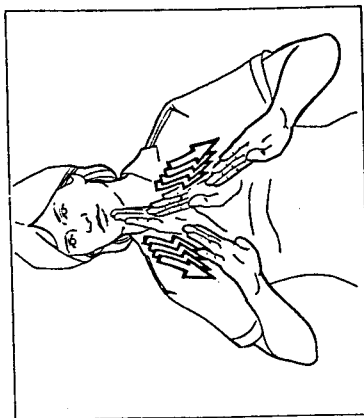
(20)   CHARACTERISTICALLY-QUIET/TACITURN

Now, what will happen if the grammar allows derivational rules to apply to each other's outputs? Application of the Characteristic Adjective Rule to (19) or of ISH to (20) would produce a sign whose movements are both circular and trilled. And such a sign exists:

(21)   CHARACTERISTICALLY-QUIETISH

Given the two derivations that would produce it, (21) should be ambigous between the meanings in (22).

(22)a.   [[CHARACTERISTICALLY-QUIET]-ISH]
    b.   [CHARACTERISTICALLY-[QUIETISH]]

This prediction appears to be correct.[3] Thus application of ISH and the Characteristic Adjective Rule to QUIET in different orders produces the same form (21), which is ambiguous between the two meanings in (22). The crucial point is that (21) manifests both phonological and semantic properties attributable to the application of the Characteristic Adjective Rule and ISH. It must therefore result from the application of both rules, showing that rules of derivational morphology can apply to each other's outputs. Further examples of this appear in the Appendix.
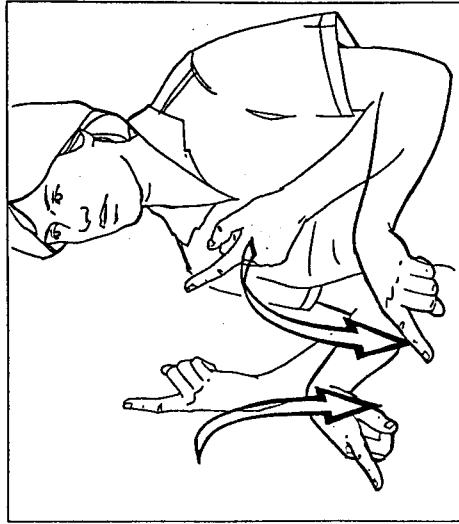
4. PHONOLOGICAL RULES

4.1. *Weak Drop*

Battison (1974, 1978) called attention to the fact that some two-handed signs can be executed with only the strong hand under certain conditions.
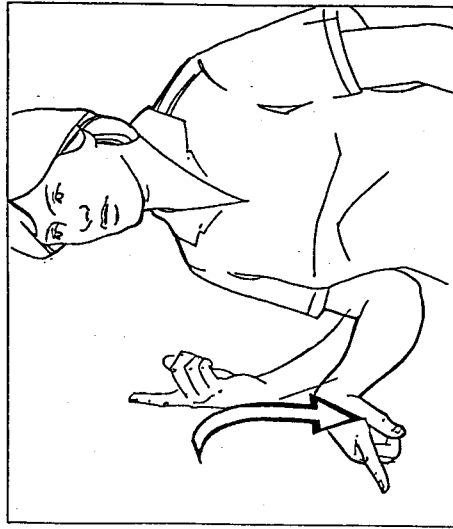
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³ Because the two meanings are so close, in practice it is difficult to distinguish them.

This is optional and especially prominent in rapid or relaxed signing. For example, HAPPEN (23) is a two-handed sign which may also appear as (24) with the weak hand at the side.

(23) HAPPEN

(24) HAPPEN

We call this phenomenon WEAK DROP. Of the factors Battison cites as relevant to the applicability of Weak Drop, only one concerns us here: alternating signs do not undergo Weak Drop.

(25) Weak Drop
    Input: Non-alternating
   Phonological change in output: One-handed

Instead of positing Weak Drop, could we take the one-handed forms as basic and derive two-handed variants of the same sign by positing a rule ('Weak Prop') that makes one-handed signs two-handed? There are two types of arguments against this proposal.

First, to prevent one-handed signs with no two-handed variants from undergoing 'Weak Prop', it would be necessary to mark with a diacritic feature all signs that undergo the rule. Which signs undergo 'Weak Prop' would not be predictable, since there are minimal pairs of one-handed versus two-handed signs that could not be distinguished in phonological terms if all signs with both a one-handed and a two-handed variant were underlyingly one-handed. The two-handed sign INTERESTING (26), for example, has a one-handed variant (derived by Weak Drop under our proposal) that is homonymous with LIKE (27).
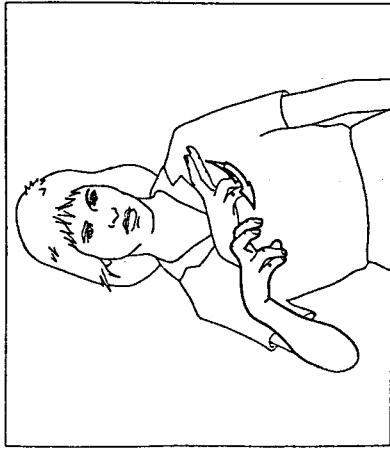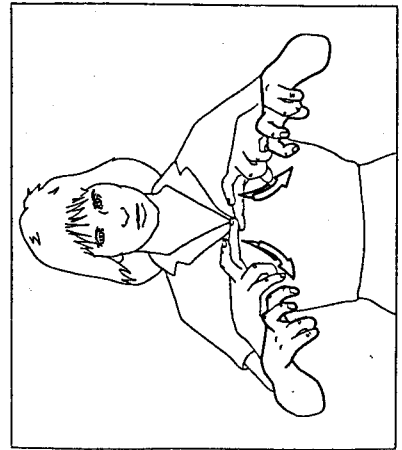
(26) INTERESTING

(27) LIKE
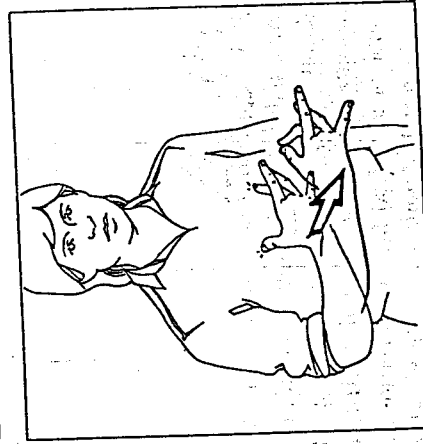
LIKE, however, has no two-handed variant. The two-handed form is thus unambiguously INTERESTING, while the one-handed form is ambiguous: it could be LIKE or the Weak Drop form of INTEREST-ING. Under the Weak Drop proposal, it woud be necessary to mark INTERESTING with a diacritic feature saying that it can undergo Weak Prop. Under the Weak Drop proposal, no such diacritics are necessary. Which two-handed signs have one-handed variants is predictable from their phonological properties to which Weak Drop is sensitive.[4]

Second, there would be no non-ad-hoc way to specify weak hand features under the Weak Prop proposal. For example, consider the Weak Drop forms ANALYZE (28) and READ (30). The two-handed forms are (29) and (31), respectively.
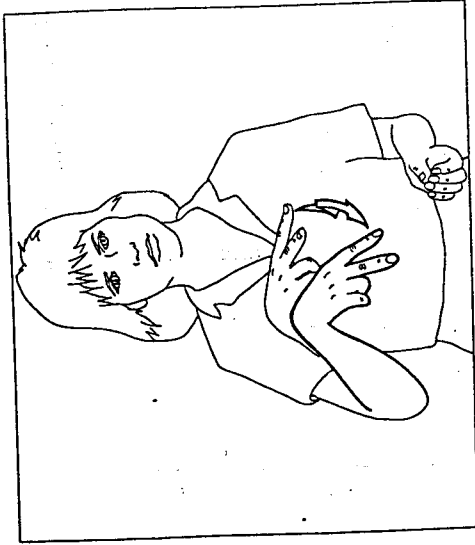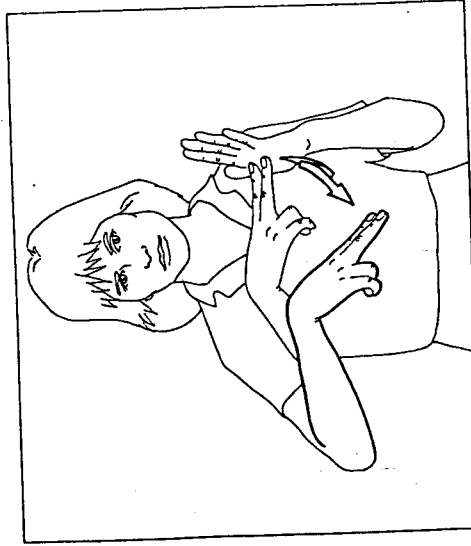
(28)   ANALYZE (Weak Drop)

(29)   ANALYZE

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[4] There are a number of such pairs, including PARTY and PURPLE, NOTHING and FURNITURE, PLAY and YELLOW.

(30)   READ (Weak Drop)

(31)   READ

Under the Weak Prop proposal there would be no way to predict that in (29) the weak hand assumes the handshape and movement of the strong hand, while in (31) it assumes the flat B handshape and does not move. Why is it not the other way around? If the two-handed forms are basic, the relevant information will be in the lexical entry and the one-handed forms can be derived by Weak Drop. In the same way, from the one-handed forms of OPEN (32) and DEAD (34) there is no way to

predict the orientation of the weak hand in the two-handed forms (33) and (35), respectively.

(32)   OPEN (Weak Drop)

(33)   OPEN

(34)   DEAD (Weak Drop)

(35)   DEAD

In general, the Weak Prop proposal would have no way to predict weak hand handshape features (as in (28)–(31)), orientation features (as in (32)–(35)), or location features (e.g. ADDRESS versus SOLDIER) from one-handed forms. Further, from the Weak Drop form it is impossible to predict whether, in the full form, the weak hand moves in the same direction as the strong hand (as in PLAN and READY), in the opposite direction (as in LINE), or not at all (as in READ, STUDY).

In brief, two-handed forms must be listed in the lexicon because this allows us to specify those weak hand features which cannot be predicted from strong hand features. We therefore reject the Weak Prop proposal in favour of Weak Drop.

4.2. Weak Freeze

Some two-handed signs in ASL have alternant forms in which the weak hand is 'frozen', i.e., it displays handshape, orientation, and location features but does not manifest the movement seen in the strong hand. These forms contrast with those derived by Weak Drop, where the weak hand drops to the side. The only difference between (9) and (36) is the lack of weak hand movement in (36):

(36)　ACTING (WF)

(37)　SCIENCE

(38)　*SCIENCE (WF)

There are interesting contrasts between signs that have counterparts with 'frozen' weak hands and those that do not. For example, the signs ACTING and SCIENCE both have alternating circular movement; however, only ACTING has an alternant form in which the weak hand freezes.

CONVERSING and ATTENTION are similar in handshape and orientation, but only CONVERSING has a form with frozen weak hand.

Given the similarity of such pairs, what determines which two-handed signs allow the frozen alternant form? A necessary prerequisite for 'freezing' in these pairs is trilled movement. While both ACTING and SCIENCE have alternating circular movement, the movement in ACTING is trilled. CONVERSING also has trilled movement, while

ATTENTION does not. Similarly, the sign DOESN'T-MATTER has two forms: one with ordinary alternating movement and one with a trill. Only the trilled form is possible with a frozen weak hand. We account for the frozen weak hand by a phonological rule we call WEAK FREEZE that applies to two-handed signs with trilled movement, freezing the trill in the weak hand.

Weak Freeze can be stated tentatively as follows:

(39) *Weak Freeze*
      Input: Trilled movement

      Phonological change   Absence of trilled
   *in output:*   movement in weak hand

In fact, signs with trilled movement are not the only ones with Weak Freeze forms. Signs such as FINALLY, SUCCESSFUL, FAMOUS, CHARACTERISTIC-OF, CRAZY-FOR, and DOESN'T-MATTER have intensive forms made with tensed musculature (Klima et al 1979): FINALLY!, VERY-SUCCESSFUL, VERY-FAMOUS, VERY-CHARACTERISTIC-OF, VERY-CRAZY-FOR, REALLY-DOESN'T-MATTER. The non-intensive forms of these signs do not have Weak Freeze forms, but their intensive forms do. Given examples like these, it seems that what makes Weak Freeze possible may be tenseness, of which trilled movement is just a special case. Rule (39) would then have to specify tenseness instead of trilled movement as the input condition. While this may turn out to be correct, we specify trilled movement because the effects of Weak Freeze on trilled forms are sufficient to demonstrate the rule interactions relevant here.

In the examples of Weak Freeze cited so far, the weak hand loses all movement. But (39) specifies that only trilled movement is lost. This is motivated by the effects of Weak Freeze on forms with two co-occurring movements: a trilled movement and a sweeping arc movement. Such co-occurring movements are found in seriated plural forms with the meaning 'noun after noun'. In the seriated plural form (41) of CHANGE (40), with the meaning 'change after change, one change after another', the hands execute an alternating up-and-down trilled movement as they move in a sweeping arc to one side. In the Weak Freeze form (42), the strong hand moves just as it does in (41). In the weak hand, only the trilled up-and-down movement is absent; the sweeping arc movement is not. Although the weak hand does not make a trill, both hands make a sweeping arc movement.
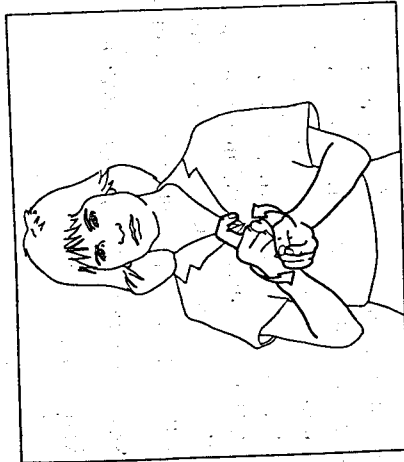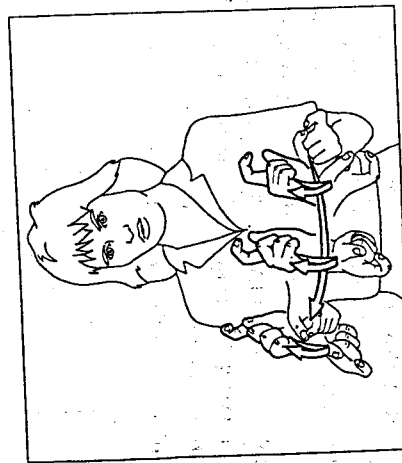
(40) CHANGE

(41) CHANGE-AFTER-CHANGE
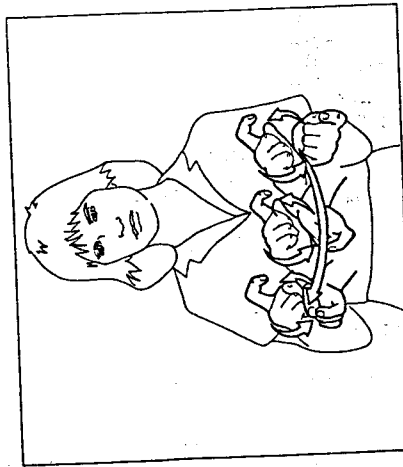
(42) CHANGE-AFTER-CHANGE (WF)

Weak Freeze applies productively to seriated plurals, e.g., EVENTS, TRANSLATIONS, LANGUAGES, EXPLANATIONS, CLASSES, GROUPS.

4.3. Interaction of Derivational Rules and Weak Freeze

With derivational rules in the lexicon and phonological rules in a post-lexical phonological component, the architecture of the model in (2) predicts that derivational rules will feed phonological rules. We have seen two derivational rules that add trills: the Activity Noun Rule (10) and the ISH Adjective Rule (18). Given a basic form and a trilled form derived by one of these rules, only the trilled sign may have a Weak Freeze form. The basic form ACT (4) does not have trilled movement, and a Weak Freeze form (43) is disallowed. However, the derived activity noun ACTING (9) is trilled and allows Weak Freeze, as (36) showed.

(43)　*ACT (WF)
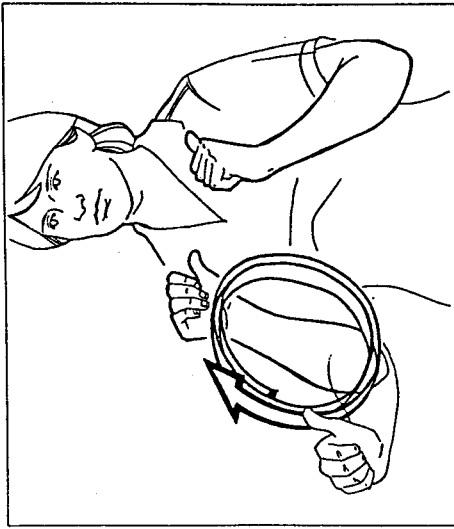
We can see from other pairs of untrilled basic forms and trilled derived forms that Weak Freeze applies only to the latter. The sign YOUNG does not have a Weak Freeze form, but YOUNGISH, derived by the ISH Adjective Rule (18) does. The verb ICE-SKATE does not allow Weak Freeze but the activity noun ICE-SKATING does.

In contrast to the above derivational rules, the Characteristic Adjective Rule derives adjectives whose movement is circular but *not* trilled. Such adjectives consequently do not have Weak Freeze forms:

neither QUIET nor its characteristic adjective TACITURN has a Weak Freeze form.

(44)　*QUIET (WF)
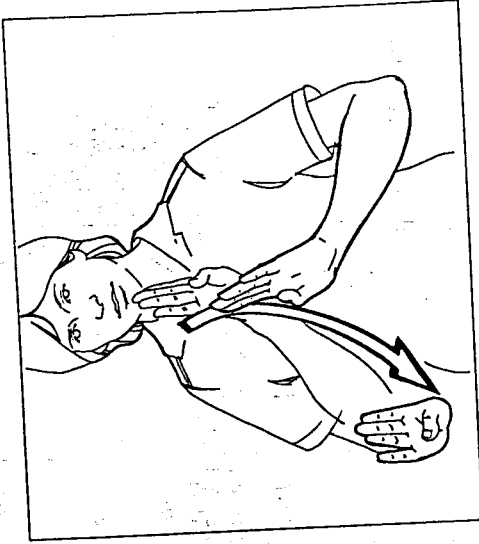
(45)　*TACITURN (WF)
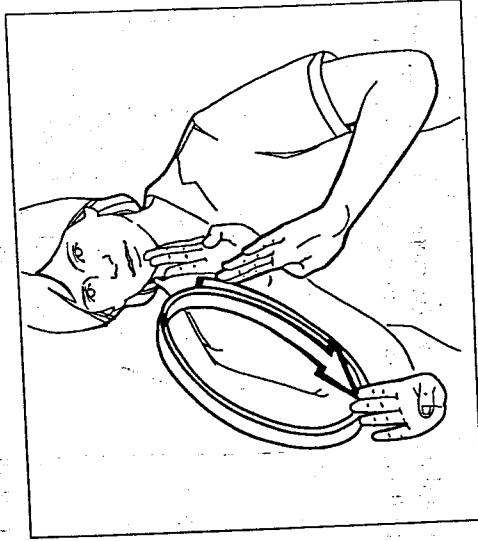
But if an ISH Adjective is formed from a characteristic adjective, e.g. QUIETISH (19) or TACITURNISH (21), Weak Freeze forms are possible:

(46) QUIETISH (WF)

(47) TACITURNISH (WF)
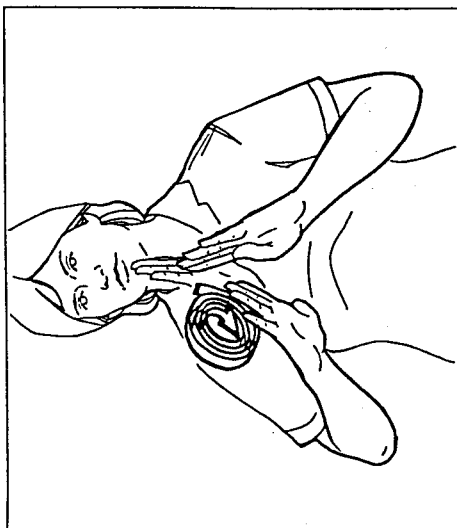
The crucial point is that the Activity Noun Rule and ISH both produce trilled movement, and this is what makes Weak Freeze applicable.

4.4. Interaction of Phonological Rules

The model in (2) predicts that phonological rules can feed each other. This can be seen from the interaction of Weak Freeze and Weak Drop. The key fact is that alternating signs cannot undergo Weak Drop. When

an alternating sign loses weak hand movement by Weak Freeze, it is no longer alternating and can undergo Weak Drop, while the alternating form from which it is derived cannot.

For example, ACT (4) cannot undergo Weak Drop since it is alternating. However, the alternating activity noun ACTING (9) is trilled and consequently can undergo Weak Freeze. Weak Freeze turns off the trilled movement in the weak hand, which makes the sign non-alternating. The resulting form can therefore undergo Weak Drop. The Weak Freeze form ACTING (36) thus undergoes Weak Drop, producing a sign like (36) but with the weak hand dropping to the side. Thus, Weak Freeze feeds Weak Drop.

Now consider the verbs CHAT (48) and RAP (49).

(48) CHAT

(49) RAP

RAP is alternating, CHAT is not. For this reason, CHAT can undergo Weak Drop, while RAP can not. Thus CHAT has a one-handed variant, but there is no one-handed variant of (49). Lacking trilled movement, neither CHAT nor RAP can undergo Weak Freeze.
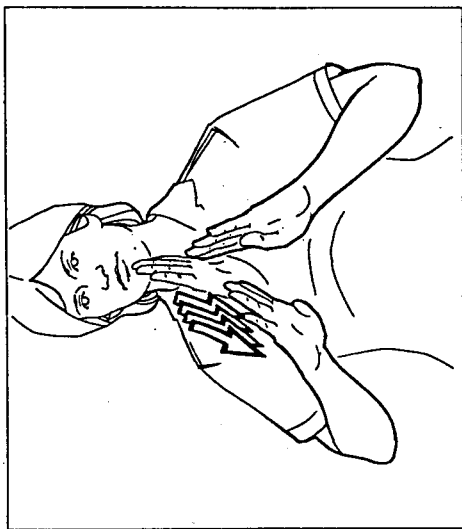
The corresponding activity nouns CHATTING (50) and RAPPING (51), however, are trilled as a result of the Activity Noun Rule. Consequently, both undergo Weak Freeze, which produces (52) and (53).

(50)   CHATTING
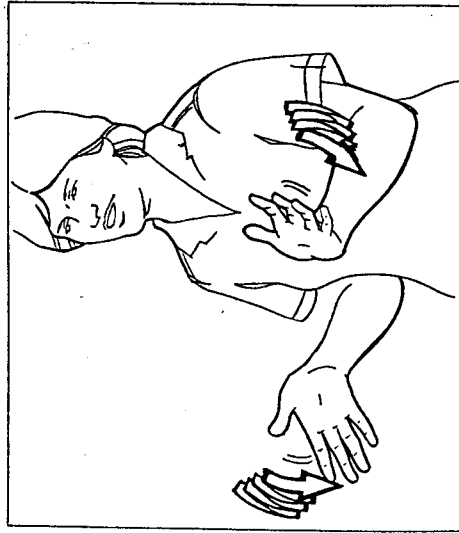
(51)   RAPPING
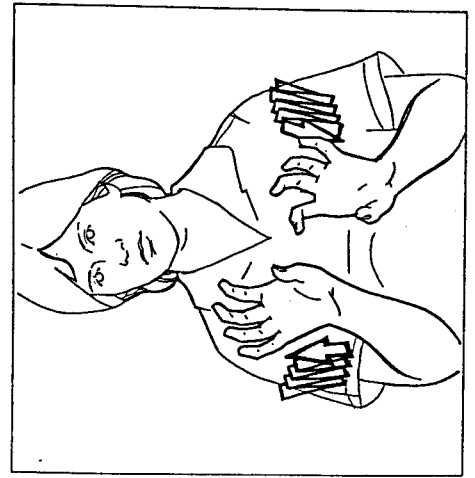
(52)   CHATTING (WF)
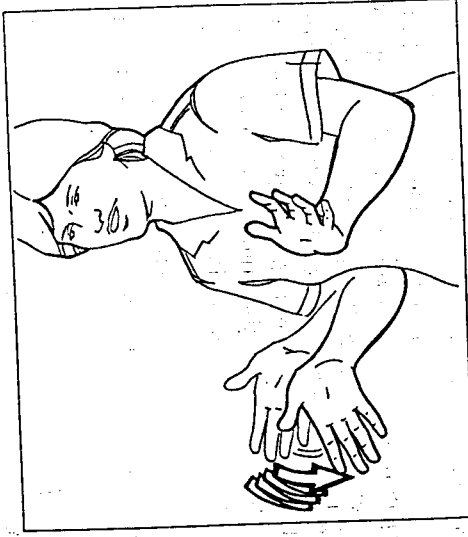
(53)   RAPPING (WF)
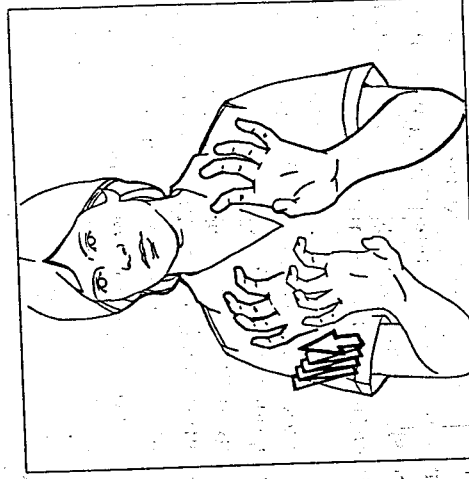
Although the verbs CHAT (48) and RAP (49) contrast in their ability to undergo Weak Drop, the Weak Freeze forms (52) and (53) are both non-alternating and consequently can undergo Weak Drop. Thus there are one-handed variants of both (52) and (53).[5]

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[5] The one-handed variant of (52) could be derived either from (52) or from (50). The one-handed variant of (53), however, cannot be derived from (51), which is alternating. More interestingly, these forms provide an argument that Weak Freeze forms result from application of a phonological rule. An alternative would be to take Weak Freeze

Alternating signs cannot undergo Weak Drop. The fact that Weak Freeze makes signs non-alternating makes them eligible for Weak Drop, showing that Weak Freeze feeds Weak Drop.

5. EVIDENCE FOR A POST-LEXICAL PHONOLOGICAL COMPONENT

Chomsky and Halle's (1986) model of generative phonology had all phonological rules in a post-lexical phonological component. In lexical phonology some phonological rules are in the lexicon, while others are in a post-lexical phonological component. Our model (2) thus incorporates an essential feature of both the older version of phonology and the newer one: a post-lexical phonological component. The question is whether there is evidence for such a component in ASL.

All the cases of rule interaction discussed above involve feeding relations among rules. We have seen that derivational rules feed each other, phonological rules feed each other, and derivational rules feed phonological rules. All these feeding relations would be accounted for without positing any extra devices if both derivational and phonological rules are in the lexicon. In the absence of something to block such interaction, they would be able to apply to each other's outputs. One way to argue for a post-lexical phonological component is to show that it is necessary to prevent a derivational rule from applying to the output of a phonological rule. If the phonological rule is post-lexical, this result will be an automatic consequence of the architecture of the model in (2). We now give such an argument, based on the interaction of Weak Drop and the Characteristic Adjective Rule.
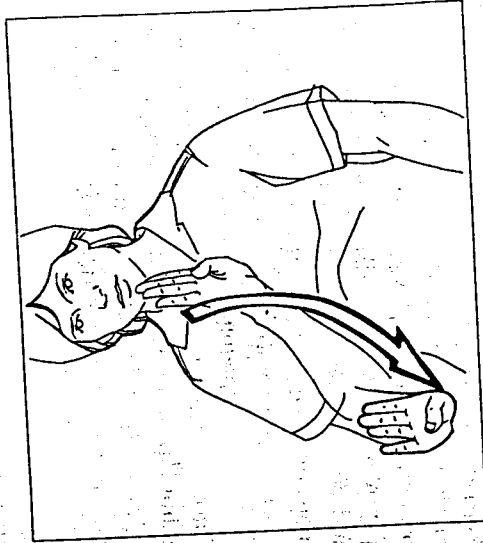
The argument is based on the fact that the Characteristic Adjective Rule treats one-handed and two-handed signs differently. Its outputs are alternating if the inputs are one-handed and non-alternating if they are two-handed. Consider the two-handed adjective QUIET (13). The Characteristic Adjective Rule will correctly derive the non-alternating characteristic adjective (14) from (13). Weak Drop derives the one-handed form (54) from (13). If derivational and phonological rules are all

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forms as basic, with a rule to derive the full forms with weak hand movement from them. This alternative must be rejected because in some cases the full forms cannot be reconstructed from Weak Freeze forms, from which it is impossible to determine whether the full form is alternating. For example, the Weak Freeze forms of CHATTING (52) and RAPPING (53) involve the same kind of movement. A rule deriving full forms from Weak Freeze forms could not account in a non-ad-hoc way for the fact that RAPPING (51) is alternating, while CHATTING (50) is not.

in the lexicon and therefore apply to each other's outputs, the Characteristic Adjective Rule will apply to (54), deriving the alternating characteristic adjective (55). But (55) is impossible. The correct form is (14) above.

(54) QUIET

(55) *TACITURN

Under the model in (2), however, this will not happen. The Characteristic Adjective Rule, like all derivational rules, is in the lexicon. Provided Weak Drop, a phonological rule, is in the post-lexical

phonological component, the Characteristic Adjective Rule in the lexicon cannot then apply to outputs of Weak Drop. Since the Characteristic Adjective Rule applies only to the two-handed, *lexical* form of QUIET (13), it correctly derives (14). If Weak Drop is a post-lexical phonological rule, the fact that (14) and not (55) is the correct form of TACITURN is an automatic consequence of the architecture of the model in (2),[6] since the one-handed form of QUIET, (54), is not available in the lexicon.

Of course, one could put Weak Drop in the lexicon and impose a parochial ordering constraint to prevent its outputs from undergoing the Characteristic Adjective Rule. Under this proposal, the impossibility of Characteristic Adjective Rule. With a post-lexical phonological component, the impossibility of this form is explained.[7]

While the post-lexicality of Weak Drop argues for the existence of a post-lexical phonological component in ASL, we have no such argument for Weak Freeze. Lexical phonology, which assigns some phonological rules to the lexicon, makes phonological rules post-lexical if, like Weak Freeze and Weak Drop, they apply across the board without exceptions to forms that satisfy the conditions for their application. It therefore seems likely that Weak Freeze, like Weak Drop, is post-lexical. The verification or refutation of this conjecture remains for future research.

6. CONCLUSIONS

We have examined three derivational and two phonological rules of ASL, arguing that derivational rules feed each other, phonological rules feed each other, and derivational rules feed phonological rules, as the architecture of the theory in (2) predicts. Further, we have argued for a post-lexical phonological component in ASL by showing that the outputs

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[6] This also provides an argument for a grammar in which two-handed signs become one-handed by Weak Drop rather than one in which the one-handed form of signs like QUIET is taken as the lexical representation, with the two-handed forms derived by Weak Drop, as discussed in section 4.1. Such a grammar would not account for the contrast between the alternating characteristic adjectives (e.g. FLEXIBLE (12)) of one-handed signs like UNDERSTANDING (11), and the non-alternating characteristic adjectives (e.g., signs like QUIET (13)).

[7] The ill-formedness of (55) in ASL has exact counterparts in oral languages. Two well-known rules of American English illustrate this: the rule that converts intervocalic /t/ and /d/ to an alveolar flap and the rule that reduces certain unstressed vowels. These rules apply to lexical /totæl/, yielding [toDil]. This is seen in the fact that [toDil] cannot serve as input to derivational rules; the derived form *totality* ([tʌtæliDiy]) is derived from lexical /totæl/, not from [toDil], derived by post-lexical phonological rules. The latter derivation would yield *[tʌDiliDiy], a form with the same status in English that (55) has in ASL.

of Weak Drop must be prevented from undergoing the Characteristic Adjective Rule – a derivational rule. With derivational rules in the lexicon and Weak Drop in a post-lexical phonological component, this, too, is predicted.

Sign language phonology provides novel support for generative phonology. Without explicit rules and grammars, one would focus on sounds and signs themselves – entities so different that the commonality of oral and signed languages would go undiscovered. Once the rules that account for the lexical and phonological structure of ASL are discovered, however, it is striking that they interact in ways predicted by the theory.

APPENDIX: SEGMENTAL REPRESENTATION AND GLOBAL FEATURES OF TWO-HANDED SIGNS

In this paper we have eschewed formal representations of ASL signs and of derivational and phonological rules. The traditional view that sign languages differ from oral languages in having simultaneous realization of feature bundles rather than segmental structures makes such formalization trivial; we would simply posit binary features such as [Bidirectional], [Alternating], etc. and posit rules changing the values of these features. As pointed out in section 2, however, this view of ASL phonological structure has recently been challenged. Because we find the arguments for ASL segmental structure convincing, we have chosen not to represent signs in terms of unitary feature bundles.

While the description of ASL signs in terms of segmental structure is a significant step forward, we have not attempted to formalize our rules in segmental terms, for no currently available system of segmental representation is adequate to support the rules discussed here. The most thoroughly worked out system to date is that proposed by Liddell (1984b) and Liddell and Johnson (1984, 1986a, Johnson and Liddell (1984) and Liddell and Johnson (1986b). However, if we adopt their system of representation for some of the sign types and rules that are central to this paper, we face serious difficulties. We illustrate this for alternating signs, which are crucial to our arguments.

Two of Liddell and Johnson's basic assumptions impede a satisfactory representation of alternating signs. The first – the Independent Articulators Assumption (IAA) – is that two-handed signs should be represented as the simultaneous activity of two independent articulators – the strong and weak hands. That is, by observing the activity of each hand in a two-handed sign, one can determine how the activity of that

hand would be represented if it were the sole articulator. The representation of a two-handed sign consists of the juxtaposition of those two representations.

Liddell and Johnson's other basic assumption – the Movement-as-Transition Assumption (MTA) – is that the two basic segment types – movement (M) and hold (H) – can be defined on the basis of certain phonetic information. They state (1986a, p. 447): "A MOVEMENT is defined as a period of time during which some aspect of the articulation is in transition," adding (p. 449): "For any movement, then, there will be an initial posture of the hand(s), a final posture of the hand(s), and a specific manner of making the transition from the first posture to the second." Liddell and Johnson posit segmental skeletons for each hand consisting of M's and H's with which are associated bundles of features representing handshape, location, orientation, etc.

The IAA and the MTA impede a satisfactory representation of alternating signs. The key point is that alternating is a global property of the sign executed by the two hands together; neither hand in isolation can be said to be alternating. Given Liddell and Johnson's basic assumptions, it is impossible to have a feature [Alternating], since all features are either features of the strong hand representation or of the weak; there is no way to represent global features of the two hands together.

The only way to represent alternating signs under Liddell and Johnson's assumptions would seem to be to represent the movement of each hand independently and reconstruct the alternating property in terms of the timing of the two hands. This is what Liddell and Johnson (1986b) do in their representation of MAYBE, a bidirectional alternating sign that is like JUDGE (8) in movement; the two signs differ only in handshape and orientation.[8]
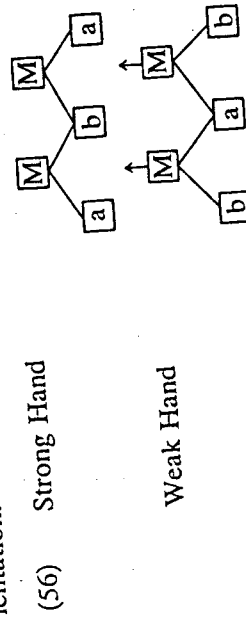
(56)   Strong Hand

        Weak Hand

The feature bundles labelled a and b have the same handshape and orientation features but differ in location features; this represents the fact that the hands are in opposite positions at the extremes of their trajectories. The arrows above the weak hand M's represent the fact that the weak hand's movements are simultaneous with the strong hand's. The sign's alternating property is thus represented not as a feature of movement, but by the alignment of the strong hand's a feature bundle with the weak hand's b bundle, and vice versa.

Now consider the representation of trilled movement under the MTA. The hand moves back and forth an indefinite number of times in stiff, rapid movements. Such movement is not "an initial posture of the hand(s), a final posture of the hand(s), and a specific manner of making the transition from the first posture to the second," as Liddell and Johnson's definition requires for it to be an M. Further, it cannot be represented as a sequence of M's since the number of movements in trilled signs is not counted and varies from one performance to another. Such an analysis would lead to the absurd result that the phonological representation consists of a different number of segments in different performances of the sign. The MTA therefore leads to the analysis of trilled movement (in signs where the hand does not change location or orientation during the trill) as a hold (H) segment, which Liddell and Johnson (1986a, p. 448) define as "a period of time during which all aspects of the articulation are in a steady state." A trilled movement must thus be considered a "steady state", to be represented as a feature of the H.

Internal to Liddell and Johnson's assumptions there is another argument for treating a trill as a manner feature rather than attempting to reconstruct it in segmental terms. This is the fact that in signs like CHANGE-AFTER-CHANGE (41), the hands execute a sweeping movement from one location to another while the trill is in progress. The MTA requires representation of the sweeping movement as an M. The trill must therefore be represented as a manner feature ([+Trilled]) rather than as a sequence of M's. Under Liddell and Johnson's assumptions, then, [+Trilled] may be a feature of either an H or an M.

This conclusion bears on the formulation of ISH (18) and the Activity Noun Rule (10). Since trilled movement must be represented as a feature [+Trilled], the optimal formulation would be to have these rules simply add the feature [+Trilled]. With adequate phonological representations, adding this feature to a basic form would yield the correct output. For example, if there were a way to represent global features of both hands

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[8] Liddell and Johnson do not propose a representation for unidirectional alternating signs, which pose additional problems that we ignore here.

many such contrasts. Among lexical signs we find pairs such as the trilled forms of DOESN'T-MATTER vs. COOL, TRAFFIC vs. BASKETBALL, and SISSY vs. NOT-YET (two-handed form). The ISH rule (18) also produces such contrasts: alternating adjectives have alternating trilled ISH forms, e.g., AWKWARDISH, PARANOIDISH, ERRORPRONISH, GROUCHYISH,[10] which contrast with the non-alternating trilled ISH forms of non-alterating adjectives, e.g., HOLY-TERRORISH, SICKLYISH, YOUNGISH. The Activity Noun Rule produces analogous contrasts, e.g., COMPETING vs. DATING and ACTING vs. BATHING. Among the signs illustrated here, the non-alternating trilled movement in TACITURNISH (21) contrasts with the alternating trilled movement in CHANGE-AFTER-CHANGE (41).

Liddell and Johnson's proposals for ASL phonological representation, while a great stride forward, are still inadequate to represent the signs and rules that are crucial to our arguments. We have pointed to the IAA and MTA as obstacles to an adequate representation of alternating signs. It is not obvious how these difficulties can be overcome within Liddell and Johnson's system. To address this issue is not our purpose here. Representations will be adequate when they facilitate the statement of derivational and phonological rules. The rules and interactions discussed here provide some of the criteria that proposed representations must meet.

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[10] Given the constraints on -*ish* in English, these would be glossed more felicitously as 'on the awkward side', 'on the paranoid side', etc.

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taken together, and if the alternating property were represented in this way, adding the feature [+Trilled] to such a representation would account for ISH adjectives and activity nouns derived from alternating signs, e.g., AWKWARDISH from AWKWARD, ACTING (9) from ACT (4), and RAPPING (51) from RAP (49). The IAA, however, leads Liddell and Johnson to posit representations with independent feature bundles for the strong and weak hands; there is no way to represent a feature such as [Alternating], which is a feature of the two hands acting together. To derive RAPPING (51) from RAP (49) with Liddell and Johnson's representations, the Activity Noun Rule (10) would have to convert an MM sequence with the representation in (56) into an H.[9] This cannot be done simply by adding a feature. Using what McCarthy and Prince (1986) call "templatic morphology", a development of McCarthy's (1981) work on Semitic, one could say that ISH adjectives and activity nouns have H morphemic templates. This would not solve the problem, however. Because the alternating property of non-trilled alternating signs like RAP (49) is represented segmentally as in (56), there is no alternating feature to be carried over to the trilled activity noun form. The representation of alternating signs in (56) makes impossible an adequate formulation of the ISH and Activity Noun rules under which the alternating property of the input forms will automatically carry over to the trilled derived forms.

In addition, Liddell and Johnson's assumptions provide no way to represent the contrast between alternating and non-alternating trilled two-handed signs. With a trill represented as a feature of an H segment (where the hands do not change location or orientation), how can one represent the contrast between the alternating trilled movement in CHATTING (51) and the non-alternating trilled movement in CHATTING (50)? This contrast cannot be represented segmentally because the MTA requires each hand's representation to be a single H. The strong and weak hand segmental tiers therefore cannot represent the fact that in CHATTING the hands move in the same direction at the same time, while in RAPPING they move in opposite directions at the same time. The contrast cannot be represented as a feature of movement because the IAA posits independent representations for the two hands and there is consequently no way to represent a feature such as [Alternating].

The contrast between RAPPING and CHATTING is only one of

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[9] This assumes the Activity Noun Rule operates on an unreduplicated lexical form; if it operates on the reduplicated form, it would have to convert an M M M sequence into an H.

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