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Attributive Compounds in Sign Language

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ABSTRACT. This paper presents a descriptive generalization on the modifier-head word order in attributive compounds in American Sign Language (ASL) and Japanese Sign Language (JSL) and proposes an account of this generalization. Coupled with the phonotactic constraint "Highest-Sign-First" (Wallis 1993), the proposed structural analysis characterizes apparently complex word order variations in a principled way. I also explore a way to explain the general right-headedness of compounds in the two languages in terms of a linearization process specific to the visual modality.*

Keywords: compounds, sign language, word order, externalization, stress, Distributed Morphology

1. Introduction

Within the minimalist theory of the syntax-phonology interface, a number of researchers have pursued an approach to attribute the cross-linguistic variations with respect to surface word order features to the varied modes of externalization used by languages. Under this approach, several phenomena have already been investigated, including head-directionality (Tokizaki 2017, Dobashi 2022), prosodic scrambling (Agbayani et al. 2015), and the availability of wh-in-situ (Richards 2010), to name a few. In this paper, adopting this view, I aim to derive the modifier-head word order variation in sequential two-sign compounds in sign languages from the uniform syntax of compounding and a linearization process specific to the visual-gestural modality.[1]

Since Klima and Bellugi (1979) (henceforth, K&B), one of the earliest works on compounds in ASL, an increasing amount of research on compounds in sign languages has been done (Liddell and Johnson 1986 (henceforth, L&J), Loos 2009, Vercellotti and Mortensen

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[1] In the present work, I do not discuss simultaneous compounds, in which the two elements of a compound are signed with two hands simultaneously (for discussion, see Santro 2018, Asada 2023).

2012 (henceforth, V&M) for ASL, Wallis 1993 for SSL, Santro 2018 for LIS and LSF, Meir et al. 2010 for ISL and ABSL, Norimatsu et al. 1989, Asada, Nomi, and Shimojima 2022 (henceforth, ANS) for JSL).[2] To the best of my knowledge, however, the distribution of modifier-head word order patterns across sign languages has not yet received an explicit generalization.

With this background, in this paper, I first provide a descriptive summary of the head-directionality of compounds in sign languages reported in previous literature (Section 2). Second, I introduce the phonotactic rule that governs the phonology of compounds in several sign languages, referred to as "Highest-Sign-First" (henceforth, HSF) (Wallis 1993, Loos 2009), and present the generalizations in terms of head-directionality and the HSF (Section 3): compounds are mostly right-headed and conform to the HSF, with some exceptions. Third, I propose a syntactic analysis of the two types of compounds, lexical and phrasal, within the Distributed Morphology (DM) framework (Halle and Marantz 1993, Harley 2009) (Section 4.1). Fourth, in an attempt to explain the general right-headedness of ASL and JSL compounds, I consider the stress-based theory of linearization (Tokizaki 2013, 2017, et seq., Tokizaki and Kuwana 2013) and suggest another account that is based on word order precedence. The proposed analysis provides an explanation of the generalization and its exceptional cases (Sections 4.2 and 4.3). Finally, I conclude the discussion (Section 5).

In this study, I adopt the three-level classification of compound types proposed by Scalise and Bisetto (2009), which is based on the grammatical relations between the elements in a compound: coordinate, attributive, and subordinate. Previous research has shown that this classification holds in several sign languages (V&M for ASL, Santro 2018 for LIS and LSF, and ANS for JSL). Some illustrative examples in ASL are shown in Table 1.

Table 1 Compounds in ASL (V&M)

	coordinate	attributive	subordinate
data	MOTHER^FATHER 'parents' HOT^WET 'humid'	DIRT^AREA 'land' BABY^DOG 'puppy'	KILL^SELF 'suicide' MONEY^GIVE 'to tip'

Among the three subtypes of compounds, I specifically deal with the "noun or adjective + noun" type of attributive compounds, in which the non-head constituent – noun or adjective –

[2] Abbreviations used in this paper: ABSL, Al-Sayyid Bedouin Sign Language; ASL, American Sign Language; DGS, German Sign Language; JSL, Japanese Sign Language; LIS, Italian Sign Language; LSF, French Sign Language; NGT, Sign Language of the Netherlands; ISL, Israeli Sign Language.

semantically modifies or expresses a property of the nominal head, such as BABY^DOG 'puppy' and DIRT^AREA 'land' in Table 1, because our focus is on the directionality of the head in an endocentric compound. I thus put aside coordinate and subordinate compounds and other types of attributive compounds, in which it may not be easy to identify the headedness or the position of the head in a compound. In this paper, I refer to the "noun or adjective + noun" type of attributive compounds as **AT** compounds.

2. Head-directionality of AT compounds in sign language

It is known that the Righthand Head Rule (henceforth, RHR) (Williams 1981), the generalization that the head of a morphologically complex word is the righthand member of that word, applies to many compounds in many languages. However, previous research has also revealed that a sizeable number of spoken languages, such as Romance, Tagalog, and Swahili, violate the RHR (Lieber 1992, Bauer 2009, among others; for an overview, see Tokizaki 2017), as illustrated in (1)–(2) (heads are shown in boldface).

(1) *French*

a. **timbre** poste 'postage stamp'
stamp postage

b. **pneu** ballon 'balloon tire'
tire ballon (Lieber 1992: 65)

(2) *Tagalog*

a. **amoy** isda 'fishy smelling'
smelling fish

b. **lasang** isda 'fishy tasting'
tasting fish (Lieber 1992: 65)

In addition, several sign languages have compounds that do not follow the RHR, which are those that are left-headed, as illustrated below.

(3) *ASL* **BED**^SOFT 'pillow or mattress' (K&B: 205)

(4) *LIS* **SCARPE** 'shoe'^ GOMMA 'rubber' 'gym shoes' (Santro 2016: 85)

(5) *NGT* **PHONE**^IMAGE 'videophone' (Klomp 2021: 167)

Intriguingly however, while many spoken languages show a rather fixed pattern in terms of the direction of a head, that is, the RHR tends to either apply or not apply (Selkirk 1982, Lieber 1992, Bauer 2009), sign languages seem to exhibit interlanguage variability. Table 2 shows the number of AT compounds with respect to head-directionality reported in previous works.

Table 2 Head-directionality of AT compounds in sign languages

Languages	Sources	Number of AT compounds		
		right-headed	left-headed	total

ASL	K&B (1979: 205–224)	5	6	11
	Loos (2001: 60)	6	3	9
	V&M (2012: 565)	35	8	43
JSL	ANS (2022 : 273–286)	12	0	12
LIS	Santro (2018)	3	4	7
LSF	Santro (2018)	2	2	4
SSL	Wallins (1983: 59)	13	1	14
Total		76	24	100

Both modifier-head and head-modifier orders are attested in these data. Let us state this variable pattern of head-directionality in (6) as our first robust description.

(6) AT compounds in sign languages may occur either in modifier-head or in head-modifier order.

(6) is further confirmed by what has been described by previous works on compounds in other sign languages, although these do not provide a list of compounds (Tkachman and Meir 2018 for ABSL and ISL, Loos 2009 for NGT and DGS). How can we account for this conflicting distribution with respect to the head position in compounds in sign languages? Some spoken languages, such as Chinese and Vietnamese, are also known to display a similar intralanguage variation, and it has been suggested that the variable pattern in these languages comes from different historical and etymological sources (Bauer 2009, Scalise and Fábregas 2010). Do the attested right and left positions of the head in a compound in sign languages also stem from diverse diachronic origins, or is the dual pattern due to the visual modality? To explore more, let us closely examine AT compounds in ASL and JSL.

3. AT compounds in ASL and JSL

3.1 “Highest-Sign-First” (HSF) in ASL

In her work on ASL compounds, Loos (2009) notes that the position of the head in compounds is influenced by the phonological constraint referred to as the HSF. In several sign languages, the HSF has been recognized as a phonological rule that governs compounds to facilitate articulation (K&B, L&J, Wallin 1993, among others). Does this phonotactic affect the position of the head in all AT compounds in sign languages? In what follows in this section, I will examine this question, extending the findings of Loos (2009) to two other works on ASL compounds (Section 3.1) and to the dictionary corpus data of JSL compounds (Section 3.2). It

will be shown that the HSF indeed plays a crucial role in determining the head-directionality but only in some type of AT compounds in ASL and JSL.[3]

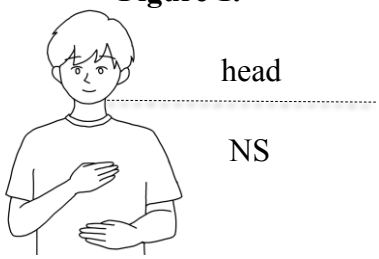
How exactly does the HSF apply to a two-sign compound? For purposes of our discussion, let us use the formulation in (7) of Wallin (1993), who proposed it based on his observation of compounds in SSL.

(7) Highest-Sign-First (HSF)

> If the two signs have their place of articulation (POA) at different levels of the body (e.g. head and hand), then the sign with the highest level (head) will tend to become the first element in the compound. Wallin (1993: 64)

Following Wallin, we divide the signing space into two parts: the head region (location on the chin or higher) and the rest of the space in front of a signer, to which I refer as neutral space (NS) (Figure 1).[4]

Figure 1.



There are then four logical possibilities of the POA level combinations of the two signs in a compound: head-to-head, head-to-NS, NS-to-NS, and NS-to-head. What is stated in (7) is that among these four combinations, compounds in sign languages may not occur with the combination NS-to-head. As L&J mentioned (1986: 474), "compounds that move upward from torso to head are extremely rare." Rather, the attested POA combinations are limited to the other three types, as illustrated by the examples in (8a–d) from ASL.

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[3] Wallin (1993) discusses another phonological constraint that governs native compounds in SSL, which states that the first sign always has the single articulator (only one hand). While this one-handedness rule may hold in compounds in SSL, Loos (2009) identifies a few exceptions to this constraint in her ASL data. Similarly, our JSL corpus data show that it is not a governing rule in JSL. Thus, we do not include this phonological feature in this study.

[4] This is a simplified division of the signing space adopted in this paper for ease of discussion. In sign language phonology, "neutral space" is often referred to as the center area of signing space, which may exclude neck, arms, and two hands, depending on the theoretical model (see e.g., Stokoe 1960, Sandler 1989, Brentari 1998).

(8) *ASL*

a.	BLUE^**SPOT**	'bruise'	<NS to NS>	(K&B: 205)
b.	YELLOW^**HAIR**	'blonde'	<head to head>	(L&J: 482)
c.	**FACE**^NEW	'stranger'	< head to NS>	(K&B: 205)
d.	**BED**^SOFT	'pillow or mattress'	< head to NS>	(K&B: 205)

Loos (2009) examined her list of 16 ASL compounds, including nine AT compounds, to determine whether the compounds are subject to the HSF. She found a few that violate this constraint (see (9) below). Given these exceptions and the overall inconstant head-directionality patten reported in several other sign languages (see Section 1), Loos concluded that "adherence to the HSF is **not an obligatory structuring principle**" and that "the linear position of the head is **of limited importance** in ASL noun and adjective compounds" (2009: 38, 91)[bold: YA].

A closer examination of the ASL data, however, reveals that the distribution is more principled. In addition to Loos (2009), we examined two other works in which the lists of AT compounds are available, K&B and V&M, in terms of the head-directionality and POA combinations of the two signs in a compound.[5] As we will see, contrary to Loos' view, the observed patterns show that the HSF does determine possible POA combinations in ASL.

The methodology of our investigation was as follows. We used the sign illustrations of the compounds that were available in the original works, and for the other compounds, which did not have the illustrations, we used two ASL online dictionaries to check the POA of the two signs that compose the compounds.[6] We then shortened the list to only the compounds for which the POA of the two signs in the compounds matched in the two dictionaries. Table 3 shows the distribution of these AT compounds collected from Loos (2009), K&B, and V&M in terms of the head-directionality and POA combinations.

Table 3 Head-directionality and POA combinations of AT compounds in ASL

POA combinations	H to H	NS to NS	H to NS	NS to H
Mod-**Head** (right-headed)	1	17	15	5
Head-Mod (left-headed)	0	0	5	1

[5] V&M (2012: 565) provide the list of "attributive endocentric compounds" (total 58). Our data is based on all the AT compounds (that is, the "noun or adjective + noun" type) from this list (total 43).

[6] American Sign Language Dictionary https://www.signasl.org/; ASL Sign Language Dictionary, https://www.handspeak.com/word/

(H: head; NS: neutral space)

What emerges from this table is that most of the compounds conform to the HSF. There are six exceptions, those that involve the upward hand movement from NS to the head area (the rightmost column in Table 3), which are shown in (9).

(9) *ASL compound exceptions to the HSF*

a.	BABY^**COW**	'calf'	d.	FALSE^**FATHER**	'stepfather'
b.	BABY^**DEER**	'fawn'	e.	FALSE^**MOTHER**	'stepmother'
c.	DEATH^**NOTIFICATION**	'obituary'	f.	**COAT**^HOOD	'parka'

((9a–c, f) from Loos 2009, (9d–e) from V&M)

Setting aside these six exceptions to the HSF for now, which will be taken up in the next section, we can identify the governing pattern from this table. Most of the compounds are right-headed (e.g., (8a–b)), and left-headed compounds are restricted to those that are articulated from the head area to NS (e.g., (8c–d)). This observation suggests that AT compounds in ASL generally follow the RHR, but the order reversal of the head to the first position is triggered by a phonotactic factor to facilitate hand movement so that the movement will be downward instead of upward, conforming to the HSF. In the next section, we will see that this distributional pattern is replicated for AT compounds in JSL.

3.2 The HSF in JSL

Following the investigation of AT compounds in ASL, we examined those in JSL collected from the dictionary corpus. The data were taken from one of the most widely used Japanese-JSL dictionaries, which contains a large number of compound entries.[7] The methodology was as follows. We first listed the two-sign AT compounds from the two volumes of the dictionary, excluding those with proper nouns, fingerspelled compounds, those that incorporate a number sign, and those that occur with non-manual markers, to be consistent with the data in ASL that we examined. In total, there were 856 of this type of AT compound. Next, for these compounds, we checked the position of the head in a compound and the POA

[7] Japan National Center of Sign Language Education (ed.) (2019). *Watasitati-no-syuwa Gakusyuuziten I* [Our sign language: Learning dictionary I.] Tokyo: Federation of the Deaf (total 6039 entries); Japan National Center of Sign Language Education (ed.) (2016). *Watasitati-no-syuwa Gakusyuuziten II* [Our sign language: Learning dictionary II] Tokyo: Federation of the Deaf (total 3445 entries).

combinations of the two signs that compose each compound. The results are shown in Table 4.[8]

Table 4 Head-directionality and POA combinations of AT compounds in JSL

POA combinations	H to H	NS to NS	H to NS	NS to H
Mod-**Head** (right-headed)	26	591	165	59
Head-Mod (left-headed)	0	0	15	0

The data reveal a very similar tendency as those shown in Table 3 for ASL: compounds are predominantly right-headed. Specifically, we obtained the same three findings as those for our ASL data. First, compounds in which the two signs are articulated in the same signing area (H to H and NS to NS) are consistently right-headed. Second, all the left-headed compounds have a downward hand movement from the higher level to the lower level (H to NS). Third, similar to the ASL compounds shown in (9a–f), we found 59 exceptions to the HSF, and they are all right-headed. The three types of JSL compounds are illustrated in (10)–(12).

(10) *JSL <right-headed>*

a.	WHITE^**GOLD**	'silver'	<NS to NS>
b.	EMPEROR^**ROOF**	'imperial palace'	<head to head >

(11) *JSL <left-headed>*

a.	**EYE**^GRANDFATHER	'presbyopia'	<head to NS>
b.	**IDEA**^SAME	'sympathy'	<head to NS>

(12) *JSL compound exceptions to the HSF <right-headed>*

a.	REMOTE^**COMPANY**	'branch company'	<NS to head>
b.	LUNG^**DISEASE**	'lung disease'	<NS to head>

At this point, let us return to the only left-headed compound in ASL that is not subject to the HSF, namely, (9f) **COAT**^HOOD 'parka,' provided in Loos (2009: 65), since we did not find such a compound in our JSL data. Loos refers to this example as an exception to the HSF, but as she mentions, the transitional hand movement of the two signs that form this compound goes from shoulders (COAT) to a head (HOOD), which are physiologically adjacent to each other,

[8] Our JSL dictionary data include a much higher number of compounds than that found in our three lists of ASL compounds (K&M, Loos 2009, V&M). This is because our Japanese-JSL dictionary contains a high proportion of loan compounds from Japanese, a language rich in compounds. Our list of AT compounds in ASL also includes both native compounds and loan ones borrowed from English. We thus did not distinguish the two types in this study.

tracing the act of putting a hood over the head.[9] This suggests that the sequence /COAT-HOOD/ is not a genuine two-sign compound but rather a depictive expression such as 'a coat with hood' or 'put the hood on a coat.' Similarly, in JSL, 'parka' is signed with two repeated wrist twisting movements in the neck area, depicting the act of putting a hood on. We also find examples analogous to (9f) in JSL, as in (13), which iconically describe 'a hooded coat' in either left- or right-headed order.[10]

(13) *JSL*

a.	**COAT**^HOOD	'hooded coat'	<NS to head>
b.	HOOD(^WITH)^**COAT**	'hooded coat'	<head to NS>

In light of these observations, I argue that the ASL (9f) **COAT**^HOOD is not an AT compound and thus exclude it from the general distributional patterns of our data.

To conclude our investigation on AT compounds in ASL and JSL, the major findings on the head-directionality and (non)compliance with the HSF are summarized in (14i–iii), which are finer generalizations than the first one in (6) above and specifically address these two languages.

(14) *Generalizations on AT compounds in ASL and JSL*

i. Most compounds are right-headed, hence following the RHR.

ii. Some violate the RHR (they are left-headed) and they all have a downward transitional movement in accordance with the HSF.

iii. Some violate the HSF (using the lower hand first) but comply with the RHR.

Now, we are left with three questions: (i) what accounts for the violation cases to the HSF (14iii); (ii) what accounts for the general right-headedness of AT compounds in the two languages (14i); and (iii) what accounts for the violation cases to the RHR, that is, the presence of left-headed compounds (14ii). I address these three questions in this order.

4. Proposal

4.1 Two types of AT compounds in ASL and JSL – Generalization (14iii)

[9] See https://www.signasl.org/sign/parka.

[10] Reported by two native JSL signers from deaf families. In this paper, the acceptability judgments of the JSL examples that are not taken from the dictionary corpus (Footnote 7) (i.e., (23), (32), (33)) were independently checked and confirmed by the two informants.

Let us begin with the generalization in (14iii), which states that there are some compounds that do not follow the HSF but follow the RHR. The relevant examples in ASL (9a–e) are repeated here.

(9) *ASL compound exceptions to the HSF <right-headed>*

a.	BABY^**COW**	'calf'	d.	FALSE^**FATHER**	'stepfather'
b.	BABY^**DEER**	'fawn'	e.	FALSE^**MOTHER**	'stepmother'
c.	DEATH^**NOTIFICATION**	'obituary'			

((9a–c) from Loos 2009, (9d–e) from V&M)

These compounds all involve an upward movement of hand(s) from NS to the head area, violating the HSF. As mentioned above, Loos does not address the question of why these examples do not comply with the HSF, but the author leaves an interesting remark that these examples are productive and semantically transparent. In regard to (9a–b) BABY^**COW** and BABY^**DEER**, she notes that other potential compounds of type BABY^**X**, such as BABY^**HORSE** and BABY^**CAT**, would also both violate the HSF because HORSE and CAT are signed in the head region (2009: 66).[11] Along with example (9c), DEATH^**NOTIFICATION** 'obituary,' she includes in her list DEATH^**ARTICLE**, which is also glossed as 'obituary.' Similarly, in addition to (9d–e), V&M include in their list of AT compounds SECOND^**FATHER** and SECOND^**MOTHER,** which have the same gloss translation 'stepfather/stepmother.' The two online ASL dictionaries that we used (Footnote 6) provide several 'step-X' examples such as 'stepbrother' and 'stepdaughter,' which are all of type FALSE^**X**. The presence of several compounds that share the same lefthand member (i.e., the modifier) or the same righthand member (i.e., the head) with the "exceptional" compounds in (9) shows that these exceptions are morphologically productive and semantically compositional.

In an analogous manner, the exceptions to the HSF found in our JSL corpus, the 59 compounds (see Table 4), are all productive and semantically compositional. A total of 56 out of 59 have their "head-mate" compounds, those that share the same righthand member (i.e., the head) of the compound, listed in our dictionary corpus. The examples in (15) illustrate a few (the number of their "head-mate" compounds found in the corpus is shown in the parentheses).

(15) *JSL compound exceptions to the HSF <right-headed, NS to head>*

[11] The list of V&M also includes BABY^**DOG** (see Table 1). Similarly, JSL has the compounds BABY^**COW** and BABY^**DOG**, which have an upward hand movement, violating the HSF (these are not listed in our dictionary corpus).

a. REMOTE^**COMPANY** ‘branch company’ (6 entries for X^**COMPANY**)
b. LUNG^**DISEASE** ‘lung disease’ (11 entries for X^**DISEASE**)
c. DEFENSE^**MINISTRY** ‘ministry of defense’ (9 entries for X^**MINISTRY**)

The remaining three compounds out of 59 exceptions to the HSF include NATION^**SONG** ‘national anthem,’ NATION^**LANGUAGE** ‘national language,’ and INFORMATION^**NEWSPAPER** ‘bulletin.’ The former two examples are “modifier-mate” compounds. The latter ‘bulletin’ lacks any head- or modifier-mate compounds in our corpus, but it is rather clear that the semantics of this example are compositionally composed of the two lexical words, INFORMATION and NEWSPAPER, which are both listed in our dictionary. These data show that this type of compounds, i.e., those that do not comply with the HSF, is morphologically productive and semantically transparent.

In contrast, not all the compounds that conform to the HSF are semantically transparent, as shown by the ASL examples in (8) and those in (16) in JSL.

(16) *JSL*
a. WHITE^**GOLD** ‘silver’ b. **EYE**^GRANDFATHER ‘presbyopia’

The semantics of these compounds are not construed by the exact compositional addition of the meanings of the two elements. The difference in terms of semantic compositionality between (9) and (15), which violate the HSF, on the one hand, and (8) and (16), which conform to the HSF, on the other, suggests that these two types of compounds are structurally different.

Based on this semantic distinction and the (non)compliance with the HSF, I claim that the cases described in Generalization (14iii), namely, AT compounds that involve an upward transitional movement, such as ASL (9) and JSL (15), are phrasal compounds, which structurally differ from lexical compounds such as (8) and (16), the latter all complying with the HSF. Specifically, under the DM framework, I propose that the two types of AT compounds are syntactically analyzed as in structures (17) and (18) (the two roots that compose a compound are notated as $\sqrt{R_x}$ and $\sqrt{R_y}$).

(17) *Phrasal compounds* (e.g., REMOTE^**COMPANY** ‘branch company’ in JSL)
$[_n \sqrt{R_x} [_n\ n, \sqrt{R_y}]]$

(18) *Lexical compounds* (e.g., WHITE^**GOLD** ‘silver’ in JSL)
$[_n\ n\ [_\alpha \sqrt{R_x}, \sqrt{R_y}]]$

Phrasal and lexical compounds contain the same syntactic objects (SOs), two roots and a nominal categorizer *n*, but they differ with respect to the timing at which *n* is merged to the

structure. Phrasal compounds have the adjunction structure in (17), in which *n* is first merged with one of the two roots and the other root is adjoined into a higher position. Lexical compounds have the incorporation structure in (18), where the two roots are merged before the categorizer *n* is merged.[12]

Given the structure for lexical compounds in (18), a question may arise as to which SO counts as a head and which SO becomes a modifier. More precisely, how is the SO α in (18) labeled (Chomsky 2013, et seq.) and interpreted in the phonological and semantic interfaces? To answer this question, let us first take the simpler case of phrasal compounds. As shown in (17), the derivation starts with the SO [*n*, $\sqrt{R_y}$]. I assume, following Chomsky (2021), that a complex SO with a root and a categorizer CT such as *n* or *v*, [CT, √R], undergoes amalgamation in the process of externalization, cyclically at the phase level, thereby being interpreted as a lexical head such as nominal or verbal at the semantic interface. To define what counts as a phase, I follow Arad (2003) and consider that a CT is a phase head. On these assumptions, the complex [*n*, $\sqrt{R_y}$] in (17) undergoes amalgamation and is interpreted as a nominal head. Next, in the case of lexical compounds (18), we have two possibilities to form an amalgam, [*n*, $\sqrt{R_y}$] and [*n*, $\sqrt{R_x}$], both of which should give rise to nominal heads. I assume that in principle, these two options may survive if the lexicon of a language allows them both, although in JSL and ASL, we do not find paired compound examples that correspond to the two options.[13]

With this proposal, let us return to our generalization in (14iii). Why do some compounds, such as (9) and (15), not follow the HSF? As mentioned in the above discussion, this type of

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[12] This proposal is akin to the syntactic analysis of lexical and phrasal compounds in English, such as *blackbird* and *black bird*, put forth by Jackson and Punske (2013) under the DM framework as in (i).

(i) a. *Lexical compound* b. *Phrasal compound*
[$_{n\text{P}}$ *n* [$_{\sqrt{\text{P}}}$ √BIRD [$_{a\text{P}}$ black]]] [$_{n\text{P}}$ [$_{a\text{P}}$ black] [$_{n\text{P}}$ *n* √BIRD]]

Our analysis differs from theirs in that the modifier in both types of compounds is merged as a bare root while in their analysis, it is an *a*P or an *n*P. My proposal relies on the assumption that roots may phonologically appear without being categorized in some languages (Nishiyama 2020 and others for Japanese, Zhang 2007 for Chinese; see also Section 4.3) and that the modifier in JSL compounds is not a full-fledged word (see ANS for empirical arguments). In the present study, I leave open whether a nominal or adjectival modifier is a phrase or a root. More investigation is needed on this point.

[13] If we extend the current analysis to Japanese, we can find minimal pairs of compounds that could be considered as being derived from the same SO of type [*n*, [$\sqrt{R_x}$, $\sqrt{R_y}$]], such as *hati-mitu* 'honey'/*mitu-bati* 'honey bee' and *nyuu-gyuu* 'milk cow'/*gyuu-nyuu* 'cow milk' (see Asada 2023, for a similar line of analysis of deverbal co-compounds in Japanese).

compound is morphologically productive and semantically compositional and is thus analyzed as being phrasal. This analysis provides an immediate account of (14iii) if the HSF is a word-level constraint that does not apply to phrasal compounds. In previous studies of compounds in sign languages, no explicit distinction has been made between lexical and phrasal compounds, and the HSF has thus been considered as a phonological constraint that governs all types of compounds. Likewise, in our discussion up to this point, we have adopted this view and referred to compounds that are expressed with a lower hand first such as (9) and (15) as cases of "violations" or "exceptions" to the HSF. Under the current proposal, however, I clearly distinguish the two types of compounds. If this analysis is correct and the HSF does not apply to phrasal compounds, the problem simply does not arise.

The assumption that the HSF is a word-level constraint seems to be valid, as we can see in (19–20): it does not apply to the sequences of SOs beyond the word level (IX indicates a pointing sign with a pronominal use; non-manual markers are omitted in the examples).

(19) *JSL*

a. BROTHER GLASS
<NS> <head> 'brother's glasses'

b. COOK WHO?
<NS> <head> 'Who cooks?'

(20) *ASL*

a. IX_{HE} AUNT
<NS> <head> 'his aunt' (Liddell 2003: 216)

b. IX_{I} SEE IX_{YOU}
<NS> <head> <NS> 'I see you.' (Sandler and Lillo-Martin 2006: 373)

These examples suggest that the linguistic unit over which the HSF operates is morphologically smaller than a phrase. Note that according to the formulation in (7) above, this phonotactic rule bans an upward movement, which would otherwise go against the ease of articulation. It is therefore likely that the HSF applies to a linearization process of the two elements that are spelled out at the same phase level, hence only to lexical compounds, not to phrasal compounds, the latter being analyzed as $[_n\sqrt{R}_x\ [_n\ n,\ \sqrt{R}_y]]$ in (17), where one of the two roots (i.e., $\sqrt{R}_x$) is located outside the phase. With this crucial assumption, the previously reported "violation" cases now become vacuous, since they are phrasal compounds, to which the HSF does not apply.

An important caveat is in order. Our assumption that the HSF is a word-level constraint does not imply that phrasal compounds only occur with an upward transitional movement as observed with examples (9) and (15). As it states, the HSF is irrelevant to phrasal compounds,

and hence, phrasal compounds may occur in any type of POA combination. What the HSF restricts is only the articulation types of lexical compounds. To summarize, therefore, we expect the POA combinations for lexical and phrasal compounds that are shown in Table 5.

Table 5 POA combinations of lexical and phrasal AT compounds in ASL and JSL

POA combinations	H to H	NS to NS	H to NS	NS to H
compound type	both lexical and phrasal			phrasal only

This pattern exactly corresponds to our ASL and JSL data in Tables 3 and 4. As expected from the four POA combinations available for phrasal compounds, we can find minimal pairs of this type of compound with different POA combinations. For example, the JSL corpus includes head-mate phrasal compounds that occur with different POA types, such as (21) and (22).

(21) *JSL* a. LUNG^**DISEASE** 'lung disease' <NS to head>
b. POLLEN^**DISEASE** 'pollen allergy' <head to head>

(22) *JSL* a. MONEY^**BATH** 'public bath' <NS to head>
b. OPEN.AIR^**BATH** 'open-air bath' <head to head>

The proposed adjunction analysis for phrasal compounds can correctly capture the morphological productivity and semantic transparency of this type of compound seen above. In our adjunction structure in (17), a modifier root adjoins to a noun, and the meaning of a compound is thus construed as the sum of the meanings of the modifier and the head noun. In contrast, in the case of lexical compounds, analyzed as in (18), the modifier is incorporated within a word, and the meaning of that complex is listed as one single word in the lexicon of a language. We thus expect that in a lexical compound, the type of modifiers that can appear is more limited, exhibiting a lexical gap. This expectation is met in the following examples:

(23) *JSL*
a. *RED^GOLD (intended) 'copper' cf. WHITE^**GOLD** 'silver'
b. ***EYE**^GRANDMOTHER (intended) 'women's presbyopia'
cf. **EYE**^GRANDFATHER 'presbyopia'

The putative lexical compounds in (23a–b), although they may be semantically possible, are not acceptable, showing that they are not as productive as phrasal compounds such as (21) and (22).

In this section, I proposed the DM-based structural analysis of the two types of AT compounds in ASL and JSL, lexical and phrasal, and claimed that the compounds that have an

upward hand movement from NS to the head area are phrasal compounds. The statement in (14iii) is, therefore, now deemed to be vacuous and can be disregarded because the HSF is immaterial for this type of compound.

4.2 Right-headedness of AT compounds – Generalization (14i)

The remaining task left from our previous discussion is to provide an account of the descriptions in (14i) and (14ii), repeated here, which concern the general right-headedness of AT compounds and its exceptions. In this section, we consider (14i).

(14) *Generalizations on AT compounds in ASL and JSL*

i. Most compounds are right-headed, hence following the RHR.

ii. Some violate the RHR (they are left-headed) and they all have a downward transitional movement in accordance with the HSF.

Although answering the long-standing, deeper question of what explains the widely attested right-headedness in words and compounds is beyond the scope of this study, I here explore two possible directions that incorporate sign language phenomena into the general discussions on the head-directionality of words and phrases.

The first avenue comes from the stress-based theory of linearization put forth by Tokizaki (2013, et seq) and Tokizaki and Kuwana (2013). Taking the minimalist view of the syntax-phonology interface that assumes universal syntax, the authors develop an approach to derive cross-linguistic parametric variations with respect to head-directionality from phonological features of languages, namely the position of stress. Specifically, Tokizaki (2017, 2022) argues that the surface order between the head and the non-head of a constituent is determined by the position of word stress in a language. This idea is built on the long-established principle that stress is assigned to the most deeply embedded element in a structure, which is in complement, i.e., non-head (Chomsky and Halle 1968, Nespor and Vogel 1986, Cinque 1993, and others). For a specific formulation of this, I refer to (24).

(24) *Non-head Stress Rule*

Main stress falls on the non-head rather than on the head in a constituent.

(Tokizaki 2015: 346)

To briefly illustrate how Tokizaki's proposal accounts for the word order variation, let us take the AT-type lexical compounds in (25) in English, a language that has lefthand stress (Tokizaki 2013).

(25) *English*

a. bláckbird b. blúefish (Liberman and Sproat 1992: 150)

According to the Non-head Stress Rule in (24) (henceforth, the NSR), stress should be assigned to the modifier, a non-head, which is *black* in (25a) and *blue* in (25b). Since English is a fore stress language, the modifier should thus surface on the left edge, just as we see.[14] Next, consider compounds in French, a right-edge stress language. As seen above in (1), repeated here, the modifier surfaces at the right edge.

(1) *French*

a.	**timbre**	poste	'postage stamp'	b.	**pneu**	ballon	'balloon tire'
	stamp	postage			tire	ballon	

This pattern also follows from Tokizaki's analysis because the modifier, a non-head, bears stress according to the NSR and is thus expected to occur on the right side of the compound in this type of languages, which we observe.[15]

Can we apply this proposal to AT compounds in ASL and JSL? We have two empirical challenges to doing so. First, the shared view among researchers is that unlike most spoken languages, sign languages do not have lexical stress or accents (Wilbur and Allen 1991, Brentari 1998, Sandler and Lillo-Martin 2006, and others). From this view, it seems difficult to derive the right-headedness of AT compounds in ASL and JSL from the position of word stress in sign languages. Second, although sign languages lack word-level stress, previous works have shown that in ASL, JSL, and several other sign languages, compounds do bear stress and that in a two-sign compound, the second element is more stressed (K&B, L&B, Sandler and Lillo-Martin 2006 for ASL; Klomp 2021 for NGT; Norimatsu et al. 1998, ANS, for JSL). To give an example, K&B report, based on their experiments conducted on 15 ASL compound pairs, that the first signs in compounds are radically more compressed than the

[14] Tokizaki (2015) advances the non DM-based, structural analysis of English lexical compounds such as *bláckbird* in terms of restrictive modification, which is in line with the NSR. See also Footnote 12 for the DM-based analysis of lexical compounds proposed by Jackson and Punske (2013), relevant to this discussion.

[15] This is a very rough illustration of languages that have lefthand and righthand stress. More specifically, languages differ in terms of the location orientations ranging from left-edge, left-oriented, right-oriented, to right-edge, and they also differ according to whether or not they have fixed stress location. For a detailed typological analysis of these varieties and their correlation with the head position, see Tokizaki (2017, et seq.).

second ones compared to their citation forms in terms of the amount of time spent signing. Importantly, this end-stress pattern applies both to right- and left-headed compounds such as BLACK^**LIGHT** 'black light' and **NAME**^SHINY 'fame' (K&B: 213) (see also L&J). The position of stress in compounds in sign languages therefore does not correlate with the position of a head, and hence is not compatible with the NSR, in contrast to what has been observed with many spoken languages. These two phonological features of the sign language modality, the lack of word-level stress and the end-stress position at the compound level, make it difficult to apply Tokizaki's stress-based linearization theory to compounds in sign languages.

Considering this difficulty, I would like to suggest another possible account of our generalization in (14i) – the right-headedness of the two types of AT compounds in ASL and JSL – while maintaining the original insight behind the NSR. The guiding intuition on the stress location that has been reiterated in many studies since Chomsky and Halle (1986) is that what is phonologically "marked or prominent" is syntactically "deep, weak, or inert" elements such as roots or non-heads (see Dobashi 2019 for a theoretical implementation under the minimalist theory). I take this asymmetry as a general requirement at the level of the syntax-phonology interface across modalities and propose a revision of the NSR as shown in (26).

(26) *Non-head Prominence Rule*

Phonological prominence falls on the non-head rather than on the head in a constituent.

The Non-head Prominence Rule in (26) (henceforth, NPR) is an extension of the NSR that applies to all languages, including those that lack word stress, such as sign languages. Assuming that this rule operates, how can prominence be assigned to a non-head in this type of language without resorting to phonological stress? I speculate that to satisfy the NPR, these languages resort to another phonological strategy to highlight prominence, namely, the precedence in word order. If, in a language that lacks specified stress directionality on the word level, the element that comes first in a compound is selected as the most prominent one, we would expect that the syntactically "weaker" non-head element takes precedence over the head to create prominence in the phonology, and this expectation will successfully capture the right-headedness of compounds stated in (14i).

With this idea in hand, let us consider how the SOs in the two types of AT compounds, lexical and phrasal, are linearized in the phonology. I proposed the structures in (17) and (18), which correspond to (27) and (28), notated here in terms of set-formation for ease of discussion.

(27) *Phrasal compounds* (e.g. REMOTE^**COMPANY** 'branch company' in JSL)

$\{\sqrt{R_x}, \{n, \sqrt{R_y}\}\}$

(28) *Lexical compounds* (e.g. WHITE^**GOLD** 'silver' in JSL)
{*n*, {√R$_x$,√R$_y$}}

According to the NPR, all languages, signed and spoken, are subject to the general requirement of syntax-phonology that assigns prominence to a non-head. My suggestion is that to do so, the sign modality uses the strategy of precedence. In the case of phrasal compounds in (27), between the two SOs that form the compound, √R$_x$ and {*n*, √R$_y$}, the one that takes precedence is the non-head √R$_x$, as per the NPR. In the case of lexical compounds in (28), we predict two options: (i) √R$_y$ is signed first if the amalgamation is formed with {*n*, √R$_x$}; and (ii) √R$_x$ is signed first if the amalgamation is formed {*n*, √R$_y$}. In both options, the non-head takes precedence over the head noun.

Note that under this analysis, the amalgamation operation that forms a nominal head renders one root in the structure without being categorized: √R$_x$ in (27) and √R$_x$ or √R$_y$ in (28). Can these "bare" roots be externalized without being categorized? Several researchers answer this question positively, arguing for the availability of root-merger for compounds in some spoken languages such as Chinese and Japanese (see Zhang 2007 for Chinese, Nishiyama 2020 and others for Japanese). Along this line of analysis, I assume that at least in some languages, including sign languages, a root may remain bare and be correctly interpreted at the interfaces.

To summarize this section, I discussed two possible accounts to explain Generalization (14i): the right-headedness of AT compounds in ASL and JSL. If the second account that I explored is on the right track, we can correctly predict (14i) in terms of the precedence-based prominence while maintaining the universal requirement of the NPR across modalities and across languages.

4.3 Exceptions to the right-headedness – Generalization (14ii)

Finally, we can address the question of why there are some left-headed compounds and why they all show up with a downward hand movement, which is the last piece of our generalization in (14). The relevant examples are repeated below:

(29)	*ASL*	**FACE**^NEW	'stranger'	<head to NS>
(30)	*JSL*	**EYE**^GRANDFATHER	'presbyopia'	<head to NS>

This type of compound involves a downward hand movement and hence follows the HSF. Note further that these examples are semantically not as transparent as phrasal compounds, as seen above. These observations suggest that they are lexical compounds. If this analysis is correct, we can then provide a straightforward account of Generalization (14ii), as follows. Let us

consider (29) **FACE**^NEW 'stranger' as an illustration. Under the current analysis, it has the structure in (31), where the two roots √FACE and √NEW are generated in the same phase and are linearized with no specification of their sequential order.

(31) [*n* [√FACE √NEW]]

In this process of linearization, as argued above, the phonological component imposes the assignment of prominence to a non-head according to the NPR, a universal requirement for all languages. However, at this point, there is another compelling requirement, the HSF, imposed by the visual modality, which selects the higher hand first in the sequential ordering. As a result, in the two-sign lexical compounds that have a lower hand for the modifier, the general "modifier-head" order is reverted to create a more economical, downward movement instead of an upward movement. This is why we observe left-headed compounds in sign languages and why they are all signed with downward movement.

In contrast, this order reversal does not happen with phrasal compounds since the phonotactic HSF applies only to SOs that are externalized at the same phase, i.e., lexical compounds, as we assume. The following data from JSL confirm this point. In contrast to lexical compounds, phrasal compounds resist the word order reversal between a head and modifier, as shown in (32)-(33).

(32)	*JSL*	a. LUNG^**DISEASE**	'lung disease'	<NS to head>
		b. ***DISEASE**^LUNG		<head to NS>
(33)	*JSL*	a. MISO^**SOUP**	'miso soup'	<NS to head>
		b. ***SOUP**^MISO		<head to NS>

The b-examples are judged to be unacceptable, even though the two-sign pairs would create a transitional downward hand movement similar to that observed with lexical compounds. This fact naturally follows from the current analysis that distinguishes lexical and phrasal compounds.

To summarize our discussion in Section 4, we have presented the accounts of the three descriptive generalizations in (14), which are repeated here:

(14) *Generalizations on AT compounds in ASL and JSL*

i. Most compounds are right-headed, hence following the RHR.

ii. Some violate the RHR (they are left-headed) and they all have a downward transitional movement in accordance with the HSF.

iii. Some violate the HSF (using the lower hand first) but comply with the RHR.

When the two signs that compose an AT compound in ASL and JSL are externalized, the modifier comes first in the phonology because it is a weak element in syntax, as an effect of the NPR. This is why most compounds follow the RHR – hence, (14i). However, in the case of lexical compounds that have the lower hand to sign the modifier of a compound, this order is reverted for an easier, more economical articulation, which places the higher hand first as an effect of the HSF. This results in the left-headed word order for this type of compound – hence, (14ii). In the case of phrasal compounds, such reversal is not observed since the modifier is structurally merged higher than the head noun and the HSF thus does not apply to them – hence, (14iii), now being vacuous, is voided.

5. Conclusion

In this paper, I first presented a descriptive generalization of the head-directionality in AT compounds in ASL and JSL based on data from previous studies and new data collected from the JSL dictionary corpus. I next showed that the word order distribution is more principled than what has been argued previously (Loos 2009, V&M). The apparent "exceptions to the HSF" are analyzed as phrasal compounds, to which the HSF does not apply. The exceptions to the RHR are analyzed as lexical compounds of which the surface order is reverted due to the HSF. Finally, in this analysis, I explored a way to derive the right-headedness of AT compounds in ASL and JSL from phonology and suggested an account that is based on the prominence of a non-head in terms of precedence in linear order.

The scope of this study is limited to the AT type of compounds in two sign languages and the empirical arguments largely rely on data from JSL. I leave for future research the extension of this proposal to other subtypes of compounds, including simultaneous compounds in sign languages (see Santro 2018, Asada 2023) and sequential coordinate and subordinate compounds in spoken and sign languages.

One interesting possible direction would be to extend the present analysis to spoken languages such as Japanese. It has been noted that this language has pitch accent but no word-level stress directionality (cf. Kubozono 2011; but see Tokizaki 2022). Interestingly, AT lexical compounds in Japanese exhibit similar properties as those discussed here for ASL and JSL, such as right-headedness and phonological assimilation known as *rendaku* voicing (e.g., aka-gami 'military call-up paper,' ao-zyasin 'blueprint'). Whether the current analysis of AT lexical compounds and the explanation of the right-headedness in terms of precedence that I suggested in this paper can apply to other languages is a question to be addressed by future work.

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