

Focus and Intensification in the Semantics of Brow Raise*

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Abstract: We argue that in American Sign Language (ASL), Brow Raise has two sorts of functions that can be distinguished by timing: it may serve well-known information-theoretic functions that can, among others, realize focus; but it may also intensify gradable constructions – a far less well-known observation. While Brow Raise *on* an expression can fulfill both functions, Brow Raise *right before* an expression preferentially has an information-theoretic function. The main findings are replicated on some examples from LSF (French Sign Language). Strikingly, these two functions mirror those found for 'stress' (= emphasis) by Bergen 2016, who argued for a unified analysis of information-theoretic effects and of intensificational effects. We sketch a unified analysis within Alternative Semantics, and discuss a further possibility within a simplified version of Bergen's own theory of 'noise-reduction' (Bergen 2016). An extension of our ASL data shows that related generalizations hold when Brow Raise is applied to a highly iconic construction (here involving a helicopter path): depending on timing, Brow Raise may serve to evoke alternatives or to intensify part of the construction.

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Authors' contributions: Schlenker initiated the project, elicited the data, developed the analysis and wrote the paper. Lamberton was the ASL consultant and then co-author for the work, and he played a key role in the construction, analysis and transcription of the ASL data (and of the non-manuals in the LSF data). In particular, he discovered the existence of Brow Raise before an expression and the fact that it does not lend itself to intensificational uses.

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Video references: each paradigm or example is followed by the reference of the video on which the sentences were recorded. For instance, *ASL*, 21, 5 refers to video 52 of the ASL folder 21, and *LSF*, 44, 56 refers to video 56 of the LSF folder 44.

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1 Introduction

1.1 Goals

Bergen 2016 argued that 'stress' (= emphasis), characterized in English by "increased loudness, duration, and changes to the fundamental frequency", has two series of effects that are not properly unified in current analyses. One series pertains to the realization of focus, typically analyzed within Alternative Semantics (e.g. Rooth 1996): contrastive focus as in (1)a, association with an overt operator (such as *only*) as in (1)b, exhaustification (possibly by a covert operator akin to *only*, *Exh*) as in (1)c (see Fox and Spector 2018 for the last case).

- (1) Stress and focus
- a. Contrastive focus: I will introduce Mary to you and then I will introduce ANN to you.
 - b. Association with focus: I only introduced ANN to Bill at the party.
=> I didn't introduce someone other than Ann to Bill at the party
 - c. Exhaustification: Sam will invite Ann OR Bill.
=> Sam won't invite them both.

But Bergen notes that another series is not currently captured within Alternative Semantics: it pertains in particular to the intensification of adjectives as in (2)a, and to the strengthening of the meaning of quantifiers as in (2)b. Bergen argues that the latter two uses are unified by the fact that stress strengthens the truth conditions: for *every* and *no* this is done by enlarging the domain of quantification: (2)a means that every girl within a larger than normal domain came. But for *some*, strengthening is effected by restricting the domain, possibly to a singleton individual (as in Schwarzschild 2002), hence a near-referential reading² (note that enlarging the domain of *some* would weaken rather than strengthen the truth conditions).

- (2) Stress and strengthening (Bergen 2016)
- a. Adjectival strengthening
 - (i) Bob is TALL.
=> Bob is especially tall
 - (ii) Alice is SMART.
=> Alice is especially smart
 - (iii) The watch is EXPENSIVE.
=> the watch is especially expensive
(Bergen 2016 pp. 126-127)
 - b. Quantifier strengthening
 - (i) EVERY girl came to the party.
 - (ii) NOBODY brought presents.
 - (iii) SOME of the students passed the test.

While the data discussed by Bergen seem clear enough, the claims are controversial: are the phenomena in (2) genuinely related to those in (1)? And if so, are they a challenge to Alternative Semantics? Bergen 2016 develops a new analysis within the Rational Speech Act model of pragmatics (e.g. Bergen et al. 2016). His leading idea is that, as in any signal transmission, there is a slight risk of corruption (henceforth 'noise'³), and that the function of stress is to reduce it. He then shows that, in simple cases at least, the phenomena in (1)-(2) can be explained by positing that the speaker uses stress to reduce, at some cost, the risk of corruption

² Here is an example mentioned by Bergen 2016 (p. 140):

(i) *Context*: Bob is addressing his students before class. He looks at a particular student.

Bob: SOME of you didn't hand me your homework yesterday.

[Understood meaning: The student that Bob is looking at did not hand in his homework yesterday.]

³ The term is obviously broader than vocal communication: there can be noise in any kind of signal, including in writing or in signs.

of part of a message that is particularly important. Besides reducing noise, the speaker also signals in this way that that part of the message carries a particularly important function, which can be exploited for communicative purposes by way of recursive reasoning (the addressee reasons on the speaker's intentions, the speaker takes into account the addressee's reasoning, etc).

Our original goal was to determine whether the cluster of phenomena that Bergen takes to be unified by stress are genuinely a natural class. We did so by asking whether eyebrow raising (henceforth Brow Raise) in American Sign Language (ASL), which is known to have the functions in (1) (e.g. Schlenker et al. 2016), also has the functions in (2). This was part of a multi-year collaboration between a semanticist and a consultant who is a native signer of ASL, with elicitation methods that have been refined over the years, as we discuss below. Due to the complexity of the data, we only focused on ASL versions of (1)a,b and (2)a. We first obtained a clear result: in our data, Brow Raise can clearly intensify adjectives. But something unexpected happened in the process: the native signer among the authors noticed that the information-theoretic functions in (1)a,b can usually be distinguished by timing from the intensification function in (2)a: while Brow Raise before an expression can serve to mark focus, it has much greater difficulty marking intensification.

Correspondingly, this article has three main goals. First, we establish that Brow Raise can have an intensification function in addition to its information-theoretic functions. Second, we show that in most cases the two functions can indeed be distinguished by timing: Brow Raise on an expression can have either function, but Brow Raise before an expression usually only has the information-theoretic function. The facts are subtle, however, as an intensification function can to some extent be regained in preposed position if Brow Raise is heightened (= involves higher eyebrow raising). Third, we show that our main findings can be replicated in some examples from French Sign Language (LSF), although we make no claims about the generality of the phenomenon.

We then discuss the consequences of our findings for theories of focus and intensification. We start by sketching an account within Alternative Semantics: it can be made to work in simple cases, but requires *ad hoc* assumptions about the semantic function of Brow Raise, and it fails to account for the fact that heightened preposed Brow Raise can have some intensificational function. We then ask whether Bergen's noise-reduction analysis could account for our generalizations: it is by design well-placed to account for the dual functions of Brow Raise, but the role of timing is an open question, which will require detailed theoretical and quantitative work in the future.

1.2 *Brow Raise*

But first, what is the semantics of Brow Raise?⁴ It is uncontroversial that it can carry information-theoretic functions, including to mark focus. But the diversity of its functions has made a unified analysis rather elusive. Quer 2016 offers a very helpful typology of extant approaches. The *prosodic view* takes sign language Brow Raise to correspond to certain prosodic properties in spoken language. In Dachkovsky's analysis, "Brow Raise corresponds to the meaning of the High boundary tone in many spoken languages" (Dachkovsky 2005, Dachkovsky and Sandler 2009, Sandler 2011). By contrast, other researchers take Brow Raise to express certain *morphosyntactic or semantic properties*. To be concrete, Brow Raise has variously been taken to mark the c-command domain of a morphosyntactic feature (Neidle et al. 2002), to be associated with [-wh] operators in syntax (Wilbur and Patschke 1999), or to mark the restriction of dyadic operators (Wilbur 2011).

It is relatively uncontroversial that any account must explain why Brow Raise is regularly used to mark focus, often in conjunction with manual modulations (and/or syntactic movement), involving in ASL and LSF further properties such as increased amplitude, speed acceleration, and longer hold times (Schlenker et al. 2016). This function seems all the more cognitively central

⁴ Here we broadly the summary from Schlenker et al. 2016.

since it is also found as a co-speech gesture marking focus in spoken language (Dohen 2005 and Dohen and Loevenbruck 2009). On the other hand, the intensification function of Brow Raise has to our knowledge rarely been discussed. We will begin to address this question in this piece, focusing on the semantic side. The correlation established by Dachkovsky and Sandler between Brow Raise and some pitch accents might dovetail with Bergen's argument for a unified analysis, in the sense that pitch accents can serve to realize the intensificational emphasis discussed by Bergen. But we will leave this more phonological analysis for future research.

1.3 *Structure*

The rest of this piece is organized as follows. We introduce our elicitation methods and transcription conventions in Section 2. In Section 3, we show that contrastive focus and association with focus can be marked by Brow Raise on or right before an expression. In Section 4, we show that Brow Raise can also intensify adjectives, but that this requires that it appear on an expression, unless Brow Raise is heightened. In Section 5, we present a partial replication of the main generalizations in LSF. An analysis within Alternative Semantics is sketched in Section 6, while Bergen's noise-reduction theory is discussed in Section 7. We present an extension of our main generalizations to a highly iconic construction involving a helicopter path in Section 8, before drawing conclusions in Section 9. An appendix discusses a highly simplified (but still quantitative) version of a noise-based analysis.

2 **Methods and transcriptions**

2.1 *Methods and limitations*⁵

Our ASL data were elicited from Lamberton, who is a native Deaf signer of Deaf, signing parents (theoretical issues were discussed with him after elicitation was complete). Our LSF data were elicited from a native Deaf signer of Deaf, signing parents. For both languages, we obtained acceptability judgments using the 'playback method', with repeated quantitative acceptability judgments (1-7, with 7 = best) and repeated inferential judgments (on separate days) on videos involving minimal pairs (for earlier uses of this method, see for instance Schlenker 2013, 2014, to appear; Schlenker et al. 2013; Kuhn 2015). Acceptability judgments pertained to entire sentences, but in many cases separate acceptability judgments were also collected on the realization of a word of interest. The goal was to get more fine-grained judgments: a sentence as a whole may seem relatively acceptable despite the fact that the non-manual on a word is suboptimal. In such cases, asking for the acceptability of the target word in this linguistic environment yields more fine-grained contrasts. We indicate clearly at the beginning of each example whether acceptability judgments pertain to the entire sentence or to a word of interest (in the latter case, acceptability judgments for the entire sentence can be found in the Supplementary Materials). Acceptability judgments appear as numerical superscripts at the beginning of sentences, thus replacing the symbols *, ??, or ? traditionally used in syntax.

When fine-grained inferential contrasts were needed in ASL, we asked for judgments of inferential strength, also on a 7-point scale (with 7 = strongest inference). Quantitatively assessing inferential strength is by now standard in experimental semantics, for reasons discussed for instance in Cremers and Chemla 2017: as they write, graded inferential judgments "may help detect otherwise hidden effects". Quantitative inferential judgments have also proven useful in work on sign language semantics (e.g. Schlenker, to appear).

In all cases, only averages of the quantitative scores obtained are provided in the text, with raw scores in parentheses when there was more than a 2-point difference among them. Raw data, including all scores and written inferential judgments (each of which was also redundantly signed on a video), can be found in the Supplementary Materials.

⁵ Similar limitations are discussed in Schlenker et al. 2016.

The playback method made it possible to ask the consultants to produce minimal pairs differing primarily by Brow Raise placement. For this reason, the *production* part was artificial, just as it would be for the creation of experimental stimuli. But the subsequent (and repeated) *judgment* task (by the same signer) made for minimal comparisons between appropriate and deviant sentences depending on the placement of focus marking.⁶ Importantly, creating truly minimal pairs with non-manuals is extremely challenging, and thus although our paradigms were minimal with respect to the presence and timing of Brow Raise, they were not as minimal as we initially hoped concerning other non-manuals. As things stand, this is just the best we could do, and more sophisticated methods will probably have to be used to produce even more minimal pairs in the future.

2.2 *Transcription conventions*

ASL data were transcribed by Lamberton himself. LSF data were initially transcribed by Schlenker for the presence and timing of Brow Raise and Brow Lowering. But for uniformity, Lamberton used the same fine-grained transcription as in ASL for non-manuals and sign modulations.⁷ While Lamberton has considerable experience with scientific transcriptions, it should be kept in mind that in the case of manual modulations and non-manuals this is often a particularly difficult task, with judgment calls involved at several junctures.

As is standard, sign language glosses are capitalized. Loci are alphabetically ordered from the dominant to the non-dominant side, hence since both consultants were right-handed, *a* was to the right of *b*, which was to the right of *c*. *IX-i* represents a pointing sign toward locus *i* (usually to realize a pronoun, with *IX-1* and *IX-2* referring to the speaker and the addressee respectively). Loci affixed to verbs represent agreement markers; a word signed in locus *i* is glossed as *WORD_i*.

For reader-friendliness, we follow Schlenker et al. 2016 in using a revised transcription system (the *SLASH-notation*⁸) in which sign modulations are indicated by modifying the glosses themselves, while non-manuals appear above the capitalized glosses, with a line indicating their duration, and iconic symbols whenever possible – in the order: 1. body changes 2. head changes 3. facial expressions, e.g. /ʔ/. We add to the conventions of Schlenker et al. 2016 a distinction between normal Brow Raise (= ^) and heightened Brow Raise (= Λ). (Longer hold times and speed accelerations were not encoded in this piece because no clear cases were found.)

(3) a. Non-manuals: / = forward lean; \ = backward lean; ‡ = raised shoulders } = head nod;

^ = normal raised eyebrows; Λ = heighed raised eyebrows; ~ = lowered eyebrows

b. Sign modulations: **WORDS** = greater amplitude; **_WORDS_** = longer hold time;

+WORD or +[WORDS]+ = speed acceleration

⁶ General remarks made by Schlenker et al. 2016 apply to the present enterprise as well: "Like the standard 'introspective' method used in linguistics, our procedure provides some data that are hard or impossible to get in a production experiment, in particular: (i) clear minimal pairs in which the same expression occurs both in focused and in unfocused form; (ii) information about the deviance of sentences in which the 'wrong' expression is focused; and (iii) fine-grained information about the truth-conditional effects of focus. Our procedure improves in two respects on the standard 'introspective' method: first, the judgments are repeated and thus their stability over time can be assessed; second, the judgments are quantitative and thus more fine-grained than the standard partition into 'acceptable' and 'unacceptable' sentences."

⁷ This has the advantage of uniformity (these fine-grained properties were transcribed with the same criteria), but this comes with obvious limitations as well: Lamberton is an ASL and International Sign signer, not an LSF signer. The reader can disregard the fine-grained details found in our LSF transcriptions if they so desire.

⁸ See the following site for more information on the SLASH-notation: https://sites.google.com/site/linguae-paris/sign_language_slash_notation

(6) (Acceptability of *OR*)⁹

Context: The speaker is an ASL instructor teaching students to sign 3-word sequences.

IX-2 WILL SIGN 'A_{NN_a} AND B_{ILL_b}', FINISH 'A_{NN_a} _____ B_{ILL_b}'

a. ^{3,7} OR (2, 4, 5)

/}Λ

b. ⁶ **OR**

/

c. ⁶ **OR**

Λ

d. ⁶ OR

Λ-

e. ^{6,7} OR

Λ-/}

f. ^{6,3} **OR**

'You will sign 'A_{NN} AND B_{ILL}', then 'A_{NN} OR B_{ILL}'. (ASL, [35.0694](#); 3 judgments)

The expectation that *OR* ought to be marked for contrastive focus, and indeed, without any emphasis, as in (6)a, *OR* is degraded. With diverse means of emphasis including Brow Raise, as in (6)b, the word is acceptable. It continues to be acceptable when just greater amplitude and forward lean are used, as in (6)c. Crucially for our purposes, Brow Raise alone can be used as well, and this is the case whether it appears on the word, as in (6)d, or right before, as in (6)e (unsurprisingly, preposed Brow Raise combined with further means of emphasis is also acceptable, as seen in (6)f). It should be noted that the Brow Raise in (6)d,e was transcribed as 'heightened', although our intention was to have even more minimal pairs with the same level of Brow Raise across sentences.

The paradigm in (4) is slightly less telling because the preposed version of Brow Raise co-occurred with greater manual amplitude (again this only highlights the difficulty of creating genuinely minimal pairs in this area). With this limitation, the findings are compatible with those in (6). The paradigm uses five letters of the manual alphabet to stand for five proper names (a standard device in ASL): *A* for Ann, *B* for Bill, etc. The name for *B_{ILL}* contrasted with *C_{HARLES}*.

(7) (Acceptability of B_{ILL_b})

Context: The speaker is trying to teach groups of students to work together.

TODAY IX-1 SEVERAL MEETING-rep FIRST MEETING A_{NN_a} C_{HARLES_b} E_{DITH_c} D_{ENIS_d},

FINISH A_{NN_a} _____ E_{DITH_c} D_{ENIS_d}

a. ^{1,3} B_{ILL_b}

/}Λ

b. ⁷ **B_{ILL_b}**

/}

c. ^{4,7} **B_{ILL_b}**

}Λ

d. ^{6,3} B_{ILL_b}

Λ-

e. ⁶ **B_{ILL_b}**

Λ-/}

f. ^{6,3} **B_{ILL_b}**

'Today I have several meetings. My first meeting is with Ann, Charles, Edith and Denis, then [I met] with Ann, Bill, Edith and Denis.'

(ASL, [35.0684](#); 3 judgments)

In (7)a, not marking contrastive focus in a clearly contrastive environment is dispreferred. A cluster of focus-marking strategies including Brow Raise is used in (7)b, with ceiling acceptability. (7)c uses the same marking strategies but without Brow Raise, with less acceptable

⁹ Note that there was a numbering error in the raw data, with c, d, e instead of d, e, f appearing in the sentences; this does not seem to have caused confusions since the consultant used all appropriate columns.

results. (7)d uses Brow Raise on *BILL*, with a head nod (which wasn't intended). (7)e has Brow Raise right before *BILL*, and as mentioned an (unintended) increase in manual amplitude. The result is acceptable, and likely due to Brow Raise rather than to greater amplitude, since the latter gave rise to decreased acceptability in (7)c. (7)f has a cluster of focus-marking properties on *BILL*, and also preposed Brow Raise, again with high acceptability.

The conclusion as this point is that contrastive focus preferentially involves Brow Raise (and can involve further means of emphasis as well), but that Brow Raise can be realized on or just before the focused word, with little difference. Future work should seek to produce even more minimal pairs to further buttress these conclusions.

3.2 Association with *ONLY*

Some particles, such as *only* in English, associate with focus and yield different truth conditions depending on which item is focused, as in (8). This makes it possible to test the effect of focus marking by way of inferential rather than acceptability judgments.¹⁰

- (8) a. I only introduced ANN to Bill at the party.
 => I didn't introduce other people than Ann to Bill at the party
 b. I only introduced Ann to BILL at the party
 => I didn't introduce Ann to other people than Bill at the party

The paradigm in (9) tests the inferential effect of Brow Raise appearing on or right before the last word of the sentence, the pronoun *IX-b*. The advantage of investigating the last word is to avoid ambiguities that arise when Brow Raise precedes a multi-word sequence: it may become unclear whether Brow Raise modifies just the following word or a longer sequence. (9)a is a control with no emphasis, while (9)b involves multiple means of emphasis: greater sign amplitude, a forward lean, a head nod, and Brow Raise. All other examples involve only Brow Raise, on or before the pronoun, and in two versions: normal Brow Raise, heightened Brow Raise (with higher eyebrows).¹¹ We intended (9)c to involve normal Brow Raise and (9)d to involve heightened Brow Raise, but both turned out to be transcribed as heightened. Preposed Brow Raise was of normal size in (9)e and heightened in (9)f, and (unintentionally) accompanied with a head nod in (9)d.

- (9) (Acceptability of the last word of the sentence.)
 YESTERDAY IX-1 1-MEET JOHN_a MARY_b. IX-1 ONLY PERMIT IX-a a-HELP-b ____ .
 a. ⁷ IX-b
 /}Λ
 b. ⁷ **IX-b**
 Δ
 c. ^{6,7} IX-b
 Δ
 d. ^{6,7} IX-b¹²
 ^-} _____

¹⁰ We include sentence-final modifiers in (8) because otherwise the last word of the sentence would also be the last word of the VP, and emphasis on it could potentially mark focus on the entire VP (this is due to rules of focus projection: for Selkirk 1995, a focused argument can F-mark its verb, which in turn can F-mark the entire VP). The judgments we report suggest that this potential ambiguity did not extend to our ASL data.

¹¹ Note that we only tested Brow Raise and not Brow Lowering in our ASL data. Brow Lowering should be investigated in this context in the future, as the consultant once noted in relation to (9)b that he "would probably use lowered eyebrows rather than raised eyebrows for this kind of emphasis." ([JL 19.10.03]).

¹² Both c. and d. have been transcribed as heightened Brow Raise, but in addition wide open eyes appear in d., which make the Brow Raise appear even stronger.

e. ⁶ IX-b

Λ-_____

f. ⁶ IX-b strong

'Yesterday John and Mary. I only allow him to help her / HER.' (ASL, [35, 1518](#); 3 judgments)

(10) Inferential question: What does the signer DISALLOW?

(i) that someone other than John help Mary

(ii) that John help someone other than Mary

(iii) something else (say what)?

(Indicate with which strength you derive the relevant inferences: 1 = no inference; 7 = strongest inference)

The signer DISALLOWS	a.	b.	c.	d.	e.	f.
(i) that someone other than John help Mary	5.7 (4, 6, 7)	3	4.3	3.3	4 (2, 5, 5)	3.7 (2, 5, 4)
(ii) that John help someone other than Mary	6.3	7	6.7	6.7	6.7	6.3
(iii) something else	6	2	3.7	2.3	3.7	3

Inferential effects were assessed by way of the difference between the target sentences, with emphasis on the last word, and (9)a, where no word was emphasized. The effect of focus on the last word was expected to only disallow one alternative, namely that John help someone other than Mary (since the pronoun referring to Mary was emphasized). This was indeed found in (9)b-f.¹³ In (9)a, the absence of emphasis made underspecified what *ONLY* associated with. In view of the consultant's responses, it seemed to associate with the entire proposition, thus disallowing all conceivable alternative propositions, namely (i) that someone other than John help Mary, (ii) that John help someone other than Mary, (iii) something else, which the consultant took to be that Mary help John.

Importantly, in all cases inferential effects are broadly indicative of association of the final pronoun with *ONLY*: Brow Raise right before the final word seems to work like Brow Raise on the final word, though possibly less clearly. There was no clear difference between normal and heightened Brow Raise. A limitation of this paradigm (and of the next one) is that we can't exclude the possibility that the head nod was crucial to mark focus in the case of preposed Brow Raise in (9)e.

A related pattern can be seen in (11). As before, the target inference is that the signer disallows that John helps someone other than Mary.¹⁴ All the examples with emphasis, in (11)b-f, give rise to the inference that the signer disallows John from helping someone other than Mary, and doesn't disallow anything else (among the options offered). Without emphasis, as in (11)a, *ONLY* seems to associate with the entire embedded proposition, hence all conceivable propositions are disallowed. Here too, we can't exclude the possibility that a head nod plays a role in focus marking in (11)e,f.¹⁵

(11) (Acceptability of the last word of the sentence)

YESTERDAY IX-1 1-MEET JOHN_a MARY_b. IX-1 ONLY WANT IX-a a-HELP-b _____.

a.⁷ IX-b

ΛΛ

¹³ However in (9)e,f, where Brow Raise occurred before a word, there was some variation across judgment tasks in the endorsement of the inference that the signer disallows someone other than John help Mary; we expected it not to be endorsed, but the effect was weaker than we would have thought.

¹⁴ The consultant noted that the "function of *ONLY* not entirely clear in these sentences. Is it "merely" - The only thing the signer is requesting is this. Or is it limiting - The signer wants this and only this to happen. For these sentences, I'll assume the latter." ([JL 19.09.29])

¹⁵ As the consultant noted, a pragmatic step is needed in all these examples: "We understand what signer wants, but for other than what is mentioned, are they neutral or unwanted/disallowed? I tend toward unmentioned = disallowed." ([JL 19.10.05], by email).

b. ⁷ **IX-b**

c. ^{6,3} IX-b normal

d. ^{5,3} IX-b strong

e. ⁶ IX-b normal

f. ^{5,7} IX-b strong

'Yesterday I met John and Mary. I only want him to help her / HER.' (ASL, [35.1476](#); 3 judgments)

(12) Inferential question: same as in (10)

The signer DISALLOWS	a.	b.	c.	d.	e.	f.
(i) that someone other than John help Mary	5	2.7	3	2.7	2.7	2.7
(ii) that John help someone other than Mary	5	6.3	5.3	6.3	5.3	5.7
(iii) something else	4 (5, 1, 6)	1.7	1.7	1.7	1.7	1.7

Importantly, there seems to be little difference between Brow Raise on or before an expression: all signal, to some extent at least, focus on the relevant word.

In sum, in our data, Brow Raise can mark focus on an expression, both in the case of contrastive focus and association with *ONLY*. There seems to be little difference between Brow Raise on a word and Brow Raise right before it. But a limitation is due to the fact that our paradigms are not entirely minimal due to the presence of head nods that may mark focus in tandem with preposed Brow Raise, in particular. As we will now see, when it comes to intensification, timing seems to matter more.

4 Intensification by Brow Raise in ASL: the role of timing

The intensification function of Brow Raise is interesting in its own right, for several reasons. As mentioned in the introduction, it is an important theoretical question to determine (i) whether it should be unified with focus-related uses, and if so (ii) how. In addition, this function has received to our knowledge little attention in the sign language literature. But it raises a particular theoretical and empirical challenge because in this case the two realizations of Brow Raise mostly part company: Brow Raise on a word can have the intensification function, whereas this seems more difficult for Brow Raise before a word. Importantly, in view of our data, we cannot claim that the effect is categorical. Rather, Brow Raise before a word might be a less effective means of intensification than Brow Raise on a word, and this can be compensated (to some extent at least) by using heightened Brow Raise in a preposed position.

4.1 Initial paradigms

First, we sought to assess how Brow Raise on its own compares to other properties that can help mark focus, as in the paradigm in (13).

(13) (Acceptability of the second word of the sentence.)

PETER ____ . JOHN TALL¹⁶.

a. ⁷ TALL

b. ⁷ TALL

¹⁶ The version of *TALL* that we used is the first one on the following webpage: <https://www.lifefprint.com/asl101/pages-signs/t/tall.htm>.

c. ^{6.7} **TALL**

Δ _____

d. ^{6.7} **TALL**

\wedge _____

e. ^{6.7} **TALL**

\wedge -/}_____

f. ⁷ **TALL**

'Peter is tall TALL. John is tall.' (ASL, [35.1512](#); 3 judgments)

- (14) *Inferential question*: How strongly to you derive the inference that (i) John is taller than Peter? (ii) Peter is taller than John? (1 = no inference; 7 = strongest inference)

One infers that	a.	b.	c.	d.	e.	f.
(i) John is taller than Peter	1	1	1	1	1	1
(ii) Peter is taller than John	1	7	7	5.3	2.7	7

Starting from a neutral realization of *TALL* in (13)a, we added in (13)b a normal emphasis effected with various manual and non-manual means, including Brow Raise. This yielded a clear intensificational effect, diagnosed by way of inferential judgments: in (13)b but not in (13)a, an inference was obtained to the effect that Peter is taller than John. Removing Brow Raise while keeping all other means of emphasis preserved the semantic effect, as seen in (13)c. In (13)d, only Brow Raise was used to emphasize the predicate, with a possibly weakened but still clear intensificational effect (this was unintentionally realized as a heightened Brow Raise). Importantly, Brow Raise before the word did not yield clear intensification, as in (13)e. Comparable judgments were obtained when the order of the predicates was reversed, as in the paradigm in (15) (here too, preposed Brow Raise in (15)e was smaller than Brow on *TALL* in (13)d).

- (15) (Acceptability of the last word of the sentence)

JOHN TALL. PETER _____ .

a. ⁷ **TALL**

/}^_____

b. ⁷ **TALL**

/}_____

c. ^{6.3} **TALL**

Δ _____

d. ^{6.7} **TALL**

\wedge -/_____

e. ⁷ **TALL**

\wedge -/}_____

f. ^{6.3} **TALL**

'John is tall. Peter is tall / TALL.' (ASL, [35.1508](#); 3 judgments)

- (16) *Inferential question*: same as (14).

One infers that	a.	b.	c.	d.	e.	f.
(i) John is taller than Peter	1	1	1	1	1	1
(ii) Peter is taller than John	1	7	7	6	2.7	7

Two possible conclusions could be drawn as this point. One is that Brow Raise before an expression just cannot intensify it. An alternative is that it may, but that the realization we picked was insufficiently strong. We will now see that more minimal paradigms provide a partial argument for the latter possibility.

4.2 Comparing normal and heightened Brow Raise

The paradigm in (17) assesses the effect on intensificational readings of two parameters: the size of Brow Raise (normal or heightened), and its timing (on or right before an expression). There are two main results: (i) heightened Brow Raise marks intensification better than normal Brow Raise; (ii) the intensificational effect is reduced when Brow Raise occurs before than on a word. As before, this is diagnosed by the strength of the inference that Peter is taller than John.

(17) (Acceptability of the second word of the sentence)

PETER ____ . JOHN TALL.

a. ⁷ TALL

^

b. ^{6.7} TALL

^

c. ^{6.7} TALL

^_

d. ⁷ TALL

^_

e. ^{6.7} TALL

'Peter is tall / TALL. John is tall.' (ASL, [35, 1504](#); 3 judgments)

(18) Inferential question (as in (14))

One infers that	a.	b.	c.	d.	e.
(i) John is taller than Peter	1	1	1	1	1
(ii) Peter is taller than John	1	4	6	2.7	4

In our initial paradigm in (17), the intensified word comes first. Partly similar effects are obtained when it comes last, as in (19): normal Brow Raise on but not before *TALL* leads to intensification. A bit more clearly than in (17), a heightened Brow Raise before the word does give rise to an intensification-like effect, albeit a reduced one. Brow Raise before *TALL* fails to yield any clear intensification.

(19) (Acceptability of the last word of the sentence)

JOHN TALL. PETER ____.

a. ⁷ TALL

^

b. ^{6.7} TALL

^

c. ^{6.7} TALL

^_

d. ⁷ TALL

^_

e. ^{6.7} TALL

'John is tall. Peter is tall / TALL.' (ASL, [35, 1500](#); 3 judgments)

(20) Inferential question (as in (14))

One infers that	a.	b.	c.	d.	e.
(i) John is taller than Peter	1	1	1	1	1
(ii) Peter is taller than John	1	5.7	6.7	3	5.3

In (21), we perform similar tests with the ASL word *NEAR*, assessing whether it means *near* or *very near* depending on whether it is intensified.

(21) (Acceptability of the last word of the sentence)¹⁷

IX-1 WANT XI-2 DRIVE ____.

a. ⁷NEAR

^

b. ^{6.7}NEAR

△

c. ⁶NEAR

^_}

d. ⁷NEAR

^_}

e. ⁷NEAR

'I want you to drive near / NEAR.' (ASL, [35.1254](#); 3+1 judgments)

(22) *Inferential question:*

Indicate with which strength you derive the relevant inferences: 1 = no inference; 7 = strongest inference:

Example: 'near' counts as 2 miles or less, 'very near' counts as 1 mile or less.

In the context of this example, for each of the following distances, do you infer that they are DESIRED? (i) ≤1 mile (ii) between 1 and 2-miles (iii) > 2 miles

Are the following distances desired?	a.	b.	c.	d.	e.
(i) ≤1 mile	7	7	7	7	7
(ii) between 1 and 2-miles	7	3.7	2	5.7	3.7
(iii) > 2 miles	1	1	1	1	1

To facilitate inferences, the written questions explicitly suggested that 'near' counts as 2 miles or less, 'very near' counts as 1 mile or less, which made it possible to ask by way of multiple choice questions which distances are desired: (i) ≤1 mile (ii) between 1 and 2 miles (iii) > 2 miles. Contrasts were found: without emphasis, as in (21)a, *NEAR* allowed for options (i) and (ii) (but not (iii)). With normal or heightened Brow Raise on *NEAR*, as in (21)b,c, option (ii) became less acceptable, indicating a 'very near' interpretation. With normal Brow Raise before *NEAR*, as in (21)d, option (ii) becomes more acceptable again, which is indicative of the possibility of a 'near' interpretation. The effect is less clear with heightened Brow Raise before the modified word, as in (21)e: it seems to be somewhat compatible with an intensificational effect.

Similar results were found with *SHORT* in (23), where heightened but not normal Brow Raise yields intensification when it appears before the adjective. Note that once again paradigms were not, despite our best efforts, entirely minimal, since a head nod occurred in (21)d,e and (22)d,e (the fact that we didn't obtain intensification suggests that, in this paradigm at least, a head nod can't have this function).

(23) (Acceptability of the last word of the sentence)¹⁸

IX-1 WANT POSS-2 LECTURE ____.

a. ⁷SHORT

^

b. ⁷SHORT

△

c. ⁷SHORT

^_}

d. ⁷SHORT

¹⁷ Since the first inferential judgment task on this question was binary (yes/no) rather than quantitative, we only provide information about the last three judgment tasks, which involved quantitative judgments instead. This also applies to acceptability judgments: for uniformity, we only use the last 3 judgments provided.

¹⁸ Here too, we only provide information about the last three judgment tasks, which involved quantitative judgments, leaving aside inferential and acceptability judgments given in the first judgment task (because its inferential component was based on a yes/no question).

\wedge -} _____
e. ^{6.3} SHORT

'I want your lecture to be short / SHORT.' (ASL, [35.1256](#); 3+1 judgments)

(24) *Inferential question*: Indicate with which strength you derive the relevant inferences: 1 = no inference; 7 = strongest inference:

Example: 'short' counts as 20 minutes or less, 'very short' counts as 10 minutes or less.

In the context of this example, for each of the following durations, do you infer that they are DESIRED? (i) ≤ 10 minutes (ii) between 10 and 20 minutes (iii) > 20 minutes

Are the following durations desired?	a.	b.	c.	d.	e.
(i) ≤ 10 minutes	7	7	7	7	7
(ii) between 10 and 20 minutes	7	3.7	2.3	5	3
(iii) > 20 minutes	1	1	1	1	1

In sum, Brow Raise on a gradable expression can serve to intensify it. The intensification effect is reduced or removed when Brow Raise occurs before an expression. For normal Brow Raise, intensification seems to disappear when the non-manual occurs before the word, but for heightened Brow Raise, a reduced intensificational effect may still be found.

5 Partial replication in LSF

We turn to a partial replication of our initial data in LSF. Because in our LSF data Brow Lowering is sometimes more natural than Brow Raise, we study both constructions in tandem (a similar study should be conducted for ASL as well). We only aim to give examples in which the contrasts we found in ASL can be replicated with repeated judgments from one consultant, with no claim about the generality of the phenomenon across sentences, nor across consultants. Thus we only provide an existence argument that *some* sentences can be found in which the effect found in ASL arises as well. Note that in these data (obtained before our more recent ASL examples), acceptability pertained only to the sentence as a whole (rather than to the target word), and inferential judgments were categorical (yes/no) rather than quantitative. Thus the judgments are, along several dimensions, less fine-grained data than those we collected in ASL. It should also be kept in mind that the transcription of Brow Raise and Brow Lowering on or before an expression was very clear, but that further non-manuals were added for reasons of comparison with our ASL data, and transcribed by Lamberton. These further non-manuals are subject to much greater uncertainty than Brow Raise and Brow Lowering.

While we do not understand all our Brow Raise/Brow Lowering data in LSF, the paradigm in (25) suggests that either construction can trigger association with the focus-sensitive particle *ONLY*. In the absence of Brow Raise or Brow Lowering, as in (25)a, association appears to be with the verb: our consultant takes the signer to reject the scenario in which there is a helping relation between Marie and Pierre. In (25)b-e, by contrast, the signer is understood to reject a scenario in which someone other than Marie helps Jean. The presence of a (slight) head nod might conceivably have played a role, but as we will see Lamberton found a head nod in all our examples with any kind of emphasis below, which means that this is unlikely to explain the contrasts we find.

(25) (Acceptability of the entire sentence)

YESTERDAY IX-1 1-MEET MARIE_b PIERRE_a. ONLY IX-1 WANT _____ b-HELP-a IX-a.

a. ⁷ IX-b

\Rightarrow I don't want someone other than Marie to help Pierre (inference not obtained)

$\} \wedge$

b. ⁷ IX-b

\Rightarrow I don't want someone other than Marie to help Pierre [3/3 judgments]

\wedge -} _____

c. ^{6.7} IX-b

=> I don't want someone other than Marie to help Pierre [3/3 judgments]

$\} \sim$
d. ⁷ IX-b

=> I don't want someone other than Marie to help Pierre [3/3 judgments]

$\sim \}$
e. ^{6.7} IX-b

=> I don't want someone other than Marie to help Pierre [2/3 judgments]¹⁹

'Yesterday I met Marie and Pierre. I only want her / HER to help him.' (LSF, [57, 3753](#), 3 judgments)

Turning to intensification, we obtained the same kinds of contrasts as in ASL in the paradigm in (26). Here *YOUNG* appears twice, but the second occurrence takes on the meaning *very young* if it co-occurs with, but not if it is preceded by, Brow Raise or Brow Lowering. In this case as well, Lamberton found head nods in all of (26)b-e, hence they are unlikely to be responsible for our contrasts. Only in case Brow Raise or Brow Lowering was on the word did we get robust intensification .

(26) (Acceptability of the entire sentence)

JEAN YOUNG. PIERRE ____ .

a. ⁷ YOUNG

≠> Pierre is younger than Jean [inference not obtained]

$\} \wedge$
b. ⁷ YOUNG

=> Pierre is younger than Jean [4/4 judgments]

$\wedge \}$
c. ^{6.8} YOUNG²⁰

≠>? Pierre is younger than Jean [inference obtained in only 1/4 judgments]

$\} \sim$
d. ⁷ YOUNG²¹

=> Pierre is younger than Jean [4/4 judgments]

$\sim \}$
e. ⁷ YOUNG

≠>? Pierre is younger than Jean [inference obtained in only 1/4 judgments]

'Jean is young. Pierre is young / YOUNG.' (LSF, [57, 3717](#), 4 judgments)

We obtained related contrasts with *SHORT* for Brow Raise, although not for Brow Lowering (for reasons we do not understand). It must be added that the inferential data in (27) are not very informative due to a Brow Raise unintentionally added on the *first* occurrence of *SHORT*.

(27) (Acceptability of the entire sentence)²²

PRESENTATION POSS-1 SHORT, POSS-2 ____ .

a. ⁷ SHORT²³

≠> your presentation is/was shorter than mine [inference not obtained]

¹⁹ In (25)e, in 1 out of 3 judgment tasks, the consultant inferred instead that the signer doesn't want Mary do so something other than help Pierre.

²⁰ There might be a slightly greater amplitude in this case.

²¹ There is a slight head movement in this case.

²² There was a total of 4 judgment tasks, but the crucial inferential questions was insufficiently precise in the 1st judgment task and was thus modified later. For this reason, we only keep the last 3 judgment tasks. Not that for acceptability judgments, it doesn't matter whether we use all 4 judgments or just the last 3, as acceptability of the entire sentence was at ceiling in all cases (the Excel file in Supplementary Materials includes all 4 acceptability scores in this case).

²³ Note that in this sentence, the *first* occurrence of *SHORT* was unintentionally given a Brow Raise (on the word). This makes it hard to interpret inferential judgments for this example.

- $\} \wedge$
 b.⁷ **SHORT**
 => your presentation is/was shorter than mine [3/3 judgments]
- $\wedge \}$
 c.⁷ **SHORT**
 ≠> your presentation is/was shorter than mine [inference not obtained]
- $\} \sim$
 d.⁷ **SHORT**
 =>? your presentation is/was shorter than mine [2/3 judgments]
- $\sim \}$
 e.⁷ **SHORT**
 =>? your presentation is/was shorter than mine [2/3 judgments]

'My presentation is/was short, yours is/was short/SHORT!' (LSF, [57,3701](#), 3+1 judgments)

We make no claim about the generality of the phenomenon: some but not all additional paradigms we have explored work in the same way, which means that there is a risk of 'cherry-picking' paradigms that work as our ASL data. In addition, in some cases Brow Raise seems to be preferable to Brow Lowering, and in other cases it is the opposite. Still, it is interesting to note that there is a hope of replicating our ASL contrasts within LSF.

6 An analysis within alternative semantics

The generalizations obtained are stated in (28):

(28) Summary of the generalizations

- a. Existence of intensification-related Brow Raise: In our ASL and LSF data, Brow Raise can intensify a gradable construction.
- b. Distinction between Brow Raise on vs. before a word:
 - (i) Brow Raise on a word can either mark standard focus (contrastive focus, association with focus) or intensification.
 - (ii-1) Normal Brow Raise before a word can mark standard focus (contrastive focus and, to some extent, association with focus), but not intensification.
 - (ii-2) In several ASL cases ((19)e, (21)e, (23)e), heightened Brow Raise in a preposed position can (unlike normal Brow Raise) mark intensification.

We now sketch an analysis in which, in the cases at hand at least, Brow Raise interacts with focus alternatives. We adopt Rooth's (1996) semantics for focus, and we assume that Brow Raise forces the appearance of F-marking (which generates alternatives) on the expression it modifies. But in order for Brow Raise to have an intensificational reading as well, we need to add something to Alternative Semantics. We propose to posit that Brow Raise makes a semantic contribution of its own, which we call 'noteworthiness'. The semantics is set up in such a way that this 'noteworthiness' contribution will make itself felt with gradable constructions, but will be usually vacuous in other cases.

(29) Main assumptions

- a. Brow Raise before an expression exclusively (or preferentially) F-marks the entire expression it modifies.
- b. Brow Raise before a gradable expression can either (i) F-mark the entire expression, or just (ii) its degree variable.
- c. Brow Raise makes a semantic contribution of its own, indicates that the asserted clause is 'noteworthy' relative to its set of alternatives. We define 'noteworthy' as: 'not entailed by most of its alternatives'

To avoid writing formulas on two lines simultaneously, we will write $\wedge E$ for Brow Raise on an expression E , and $\wedge -E$ for Brow Raise before an expression E .

The key assumptions are in (29)b,c. Per (29)b, a sign language expression such as *PIERRE* \wedge *YOUNG*, with Brow Raise on (rather than before) *YOUNG*, can receive an analysis of the form *Pierre is (at least) d_F -young*, with focus marking on the degree argument. Per (29)c, Brow Raise introduces a noteworthiness requirement. When the F-marked expression is not a member of a neo-Gricean scale, the noteworthiness requirement will usually be vacuously satisfied and the net effect will reduce to focus marking. When a degree variable is F-marked, the requirement won't be trivial: for *Pierre is (at least) d_F -young*, the noteworthiness requirement is that the clause should not be entailed by most of its degree alternatives, and hence Pierre's degree of youth should lie within the upper part of the scale, hence the intensificational effect observed.²⁴

We turn to a more precise statement of our focus-related notations, stated in (30). Informally, they just recapitulate the standard assumption (e.g. Rooth 1996) that expressions have an ordinary value and a focus value, combined with ordinary assumptions and notations from semantics (e.g. the evaluation of expressions under an assignment function s and world parameter w).

- (30) a. $\llbracket \bullet \rrbracket^{s,w,o}$ is the ordinary value of \bullet under assignment s and in world w
 b. $\llbracket \bullet \rrbracket^{s,w,f}$ is the focus value of \bullet under assignment s and in world w (technically, $\llbracket \bullet \rrbracket^{s,w,o}$ and
 c. $\llbracket \bullet \rrbracket^{s,w,f}$ are short for $\llbracket \bullet \rrbracket^{s,o}(w)$ and for $\llbracket \bullet \rrbracket^{s,f}(w)$).
 d. Focus values are defined, as in Rooth 1996, as sets of semantic objects. D is the set of entities, Deg is a (contextually specified) finite set of degrees, $Property$ is a (contextual specified) finite set of properties (of type $\langle s, \langle e, t \rangle \rangle$).
 e. As is standard, if s is an assignment function, $s[d \rightarrow d^*]$ is the function that is identical to s , with the possible exception that it assigns d^* to the variable d (in the discussion below, d will be a degree variable).
 f. We write as *young'* and *pierre'* the semantic value of *YOUNG* and *PIERRE* respectively, and adopt related conventions for other expressions.

In our general theoretical machinery, we adopt a standard rule of extensional function application whereby if F is a functor and A is its argument, $\llbracket [F A] \rrbracket^{s,w,o} = \llbracket [F] \rrbracket^{s,w,o}(\llbracket [A] \rrbracket^{s,w,o})$. Focus semantic values are defined by the procedure specified in (31), from Rooth 1996.

- (31) a. The focus semantic value of a focused phrase of semantic type τ is the set of possible denotations of type τ .
 b. The focus semantic value of a non-focused lexical item is the unit set of its ordinary semantic value.
 c. Let α be a non-focused complex phrase with component phrases $\alpha_1, \dots, \alpha_k$ and let Φ be the semantic rule for α , e.g. function application. The focus semantic value of α is the set things obtainable as $\Phi(x_1, \dots, x_k)$, where $x_1 \in \llbracket [\alpha_1] \rrbracket^f$ and \dots and $x_k \in \llbracket [\alpha_k] \rrbracket^f$.

Turning to our specific theoretical machinery, our assumptions about focus-marking, Brow Raise and gradable constructions are stated in (32), which just adapt to Alternative Semantics the general ideas we introduced in (29). In particular, (30)a states that Brow Raise on an expression can F-mark the entire expression or a degree variable it contains. (32)b states that the semantic contribution of Brow Raise is to add a requirement that $A(x)$ is noteworthy within its set of alternatives $A'(x)$, $A''(x)$, etc.

- (32) In a constituent $[\dots \wedge A \dots]$ with $A = E$ (i.e. \wedge is on E) or $A = -E$ (i.e. \wedge precedes E):²⁵
 a. formally, E must be F-marked if $A = _E$ (i.e. if \wedge precedes E), and E must be F-marked or contain

²⁴ We take the noteworthiness requirement to be associated with other means of emphasis as well, since in our data manual intensification gives rise to semantic effects. Brow Raise is special and theoretically informative because it can both co-occur with an expression and precede it.

²⁵ In our computations below, we take $-$ to be semantically vacuous (it just marks that Brow Raise is before an expression, which in turn has consequences for F-marking possibilities, hence an *indirect* effect on interpretation).

- an F-marked element* (such as a degree variable) if $A = E$ (i.e. if \wedge is on E);
 b. semantically, if E is of predicative type, for any expression A (which could be of the form E or $\neg E$),
 $\llbracket \wedge A \rrbracket^{s,w,o} = \lambda x. \llbracket A \rrbracket^{s,w,o}(x) = 1$ and noteworthy($\lambda w_s. \llbracket A \rrbracket^{s,w,o}(x), \{\lambda w_s.P(w)(x): P \in \llbracket A \rrbracket^{s,f}\}$).

(33)a explicates that a proposition is noteworthy just in case most of its alternatives don't entail it. (33)b,c introduce standard assumptions about gradable adjectives: *young* is gradable and comes with a degree argument, while *French*, which isn't gradable, doesn't have a degree argument. (33)d makes the simplifying assumption that there is a finite number of degrees (so we can easily define what it means for something to hold of 'most' of them).

- (33) a. If p is a proposition and Π is a finite set of propositions,
 noteworthy(p, Π) iff (= if and only if) most members of Π fail to entail p .
 b. *YOUNG* is represented as d -*YOUNG*, with a degree variable d as argument. It has the lexical entry:
 $\llbracket \text{YOUNG} \rrbracket^{s,w,o} = \lambda d \lambda x \ x \text{ is at least } d\text{-young in } w = \lambda d \lambda x \ \text{young}'(w)(d)(x)$.
 c. *FRENCH* does not take a degree variable as an argument, and it has the lexical entry:
 $\llbracket \text{FRENCH} \rrbracket^{s,w,o} = \lambda x \ x \text{ is French in } w = \lambda x \ \text{french}'(w)(x)$
 d. Simplifying assumption: we assume that the set of degrees is finite (to avoid comparing the size of infinite sets).

Let us now see how this analysis derives the intensified reading of \wedge *YOUNG*, with Brow Raise on the predicate. This makes two patterns of F-marking possible: on the entire predicate, or on its degree variable. We consider the latter option first. The outcome will be that Pierre is young to a degree d^* which is above d_{half} , the middle of the scale of degrees.

Let us start with (a sketch of) the computation of the ordinary value and of the focus value of d_F -*YOUNG*. It will be useful to make separate assumptions about the computation of the focus value of d_F -*YOUNG*, as in (34) (these values will be relativized to a world parameter s in the ensuing computations).

- (34) a. $\llbracket [d_F\text{-YOUNG}] \rrbracket^{s,o} = \lambda w. \llbracket [d_F\text{-YOUNG}] \rrbracket^{s,w,o} = \lambda w. \llbracket \text{YOUNG} \rrbracket^{s,w,o}(\llbracket [d_F] \rrbracket^{s,w,o}) = \lambda w. \text{young}'(w)(s(d))$
 b. $\llbracket [d_F\text{-YOUNG}] \rrbracket^{s,f} = \{\lambda w'. \text{young}'(w')(d'): d' \in \text{Deg}\}$

We assume that the degree variable of *YOUNG* is existentially closed as in the LF in (35)a, whose truth conditions are sketched in (35)b, and made more precise in a footnote²⁶; the result is that Pierre's degree of height should be above the middle of the scale.

²⁶ In greater detail:

$$\begin{aligned} & \llbracket \llbracket (35)a \rrbracket \rrbracket^{s,w,o} = 1 \\ & \text{iff for some degree } d^*, \llbracket \text{PIERRE } \wedge [d_F\text{-YOUNG}] \rrbracket^{s[d \rightarrow d^*], w, o} = 1, \\ & \text{iff for some degree } d^*, \llbracket \wedge [d_F\text{-YOUNG}] \rrbracket^{s[d \rightarrow d^*], w, o}(\text{pierre}') = 1, \\ & \text{iff for some degree } d^*, [\lambda x. \llbracket [d_F\text{-YOUNG}] \rrbracket^{s[d \rightarrow d^*], w, o}(x) = 1 \text{ and noteworthy}(\lambda w. \llbracket [d_F\text{-YOUNG}] \rrbracket^{s[d \rightarrow d^*], w, o}(x), \{\lambda w.P(w)(x): P \in \llbracket [d_F\text{-YOUNG}] \rrbracket^{s,f}\})](\text{pierre}') \\ & \hspace{15em} \text{(by (32)b)} \\ & \text{iff for some degree } d^*, \llbracket [d_F\text{-YOUNG}] \rrbracket^{s[d \rightarrow d^*], w, o}(\text{pierre}') = 1 \text{ and noteworthy}(\lambda w. \llbracket [d_F\text{-YOUNG}] \rrbracket^{s[d \rightarrow d^*], w, o}(\text{pierre}'), \{\lambda w.P(w)(\text{pierre}') : P \in \llbracket [d_F\text{-YOUNG}] \rrbracket^{s,f}\}) \\ & \text{iff for some degree } d^*, \text{young}'(w)(d^*)(\text{pierre}') = 1 \text{ and noteworthy}(\lambda w. \text{young}'(w)(d^*)(\text{pierre}'), \\ & \{\lambda w'. \text{young}'(w')(d'): d' \in \text{Deg}\}) \hspace{5em} \text{(the underlined part is obtained by (34)b)} \end{aligned}$$

$$\begin{aligned} & \text{But } \{\lambda w.P(w)(\text{pierre}') : P \in \{\lambda w'. \text{young}'(w')(d'): d' \in \text{Deg}\}\} \\ & = \{\lambda w. [\lambda w'. \text{young}'(w')(d')] (w)(\text{pierre}') : d' \in \text{Deg}\} \\ & = \{\lambda w. \text{young}'(w)(d')(\text{pierre}') : d' \in \text{Deg}\} \end{aligned}$$

(The second line above, underlined, is obtained by replacing P in the preceding line with all its possible values in the set $\{\lambda w'. \text{young}'(w')(d'): d' \in \text{Deg}\}$.)

- (35) a. $\exists d \text{ PIERRE} \wedge [d_F\text{-YOUNG}]$
 b. $[[[a]]]^{s, w, o} = 1$
 iff for some degree d^* , $[[\text{PIERRE} \wedge [d_F\text{-YOUNG}]]]^{s[d \rightarrow d^*], w, o} = 1$,
 iff for some degree d^* , Pierre is young to degree d^* , and this is noteworthy relative to (degree-)
 alternatives to this proposition,
 iff for some degree d^* , Pierre is young to degree d^* , and most (degree-) alternatives to this
 proposition do not entail it,
 iff for some degree d^* , Pierre is young to degree d^* and d^* is above most degrees of youth.

It is clear that the analysis could be tweaked by changing the meaning of *noteworthy*: if one requires that a proposition is noteworthy relative to a set of propositions just in case it is entailed by less than 10% of them (rather than less than 50% of them, as in our definition), the intensificational effect will be strengthened (as d^* will have to be within the top 10% of degrees).

We now consider the case in which \wedge triggers F-marking on the entire expression it associates with – which is the only (or preferred) possibility when Brow Raise precedes an expression. The outcome will be that the noteworthiness requirement is typically trivialized because most of the alternative propositions do not stand in an entailment relation anyway. The derivation is sketched in (36) and made more precise in a footnote.²⁷ The key is that the noteworthiness requirement will be trivialized in this case. Still, if F-marking must be justified by something, we will end up with whatever informational effects are produced by focus in standard cases, and in particular F-marking may be justified by a contrast, or by association with an operator.

- (36) a. $\exists d \text{ PIERRE} \wedge [d\text{-YOUNG}]_F$
 b. $[[[a]]]^{s, w, o} = 1$ iff for some degree d^* , $[[\text{PIERRE} \wedge [d\text{-YOUNG}]_F]]^{s[d \rightarrow d^*], w, o} = 1$,
 iff for some degree d^* , Pierre is young to degree d^* , and this is noteworthy relative to predicate
 alternatives to this proposition (obtained by replacing *young* with other adjectives)
 iff for some degree d^* , Pierre is young to degree d^* , and most predicate alternatives to this
 proposition, of the form *Pierre is French, Pierre is English, etc. do not entail it*,
 iff for some degree d^* , Pierre is young to degree d^* (as the underlined requirement is vacuous).

As a result, $\text{noteworthy}(\lambda w. \text{young}'(w)(d^*)(\text{pierre}'), \{\lambda w. P(w)(\text{pierre}') : P \in [[d_F\text{-YOUNG}]]^{s, \uparrow}\})$
 $= \text{noteworthy}(\lambda w. \text{young}'(w)(d^*)(\text{pierre}'), \{\lambda w. \text{young}'(w)(d')(\text{pierre}') : d' \in \text{Deg}\})$
 $= \text{most members of } \{\lambda w. \text{young}'(w)(d')(\text{pierre}') : d' \in \text{Deg}\} \text{ fail to entail } \lambda w_s \text{young}'(w)(d^*)(\text{pierre}')$
 $= d^* > d_{\text{half}}$ (writing d_{half} for the middle of the scale of degrees)

In the end,

$[[\exists d \text{ PIERRE} \wedge [d_F\text{-YOUNG}]]]^{s, w, o} = 1$ iff for some degree $d^* > d_{\text{half}}$, $\text{young}'(w)(d^*)(p) = 1$.

²⁷ The beginning of the derivation is the same as in (35), so we can take some shortcuts. In accordance with (31)a, we take the focus value of the focused predicate $[d\text{-YOUNG}]_F$ to be Property, a contextually determined set of properties (of type $\langle s, \langle e, t \rangle \rangle$, e.g. with Property = {french', english', ...}).

$[[[(36)a]]]^{s, w, o} = 1$

iff for some degree d^* , $[[\text{PIERRE} \wedge [d\text{-YOUNG}]_F]]^{s[d \rightarrow d^*], w, o} = 1$,

iff for some degree d^* , $[[[d\text{-YOUNG}]_F]]^{s[d \rightarrow d^*], w, o}(p) = 1$ and $\text{noteworthy}(\lambda w. [[[[d\text{-YOUNG}]_F]]]^{s[d \rightarrow d^*], w, o}(\text{pierre}'), \{\lambda w. P(w)(\text{pierre}') : P \in [[[[d\text{-YOUNG}]_F]]^{s, \uparrow}\})$

Since $[[[[d\text{-YOUNG}]_F]]^{s, \uparrow} = \{P \in \text{Property}\} = \{\text{french}', \text{english}', \dots\}$, we can continue as follows:

... iff for some degree d^* , $\text{young}'(w)(d^*)(\text{pierre}')$ and most members of $\{P \in \text{Property}\}$ fail to entail $\lambda w. \text{young}'(w)(d^*)(\text{pierre}')$.

The underlined condition will normally be vacuously satisfied and hence no intensification will be felt.

Importantly, the present analysis predicts a categorical distinction between Brow Raise before *vs.* on an adjective: only the latter should yield an intensificational reading. This is not quite correct, since in our data heightened Brow Raise can sometimes yield an intensificational reading. As things stand, this is a limitation of our analysis.²⁸

In sum, we can capture our main data within Alternative Semantics, but we must stipulate that Brow Raise doesn't just serve, in these cases at least, to F-mark expressions, but that it also makes a semantic contribution of its own ('notworthiness'). The repercussions of these assumptions would need to be assessed in greater detail. In addition, our analysis does not capture the fact that preposed Brow Raise can to some extent fulfill an intensification function if it is heightened.

7 An alternative in terms of noise-reduction

Bergen 2016 develops a unified analysis of focus and intensification within the Rational Speech Act model. As he notes, Alternative Semantics offers an account of the effect of stress analyzed as focus-marking for the examples in (1) but not the various cases of strengthening found in (2). The fact that Brow Raise has the focus-related functions in (1) and can also strengthen adjectives provides an additional argument for Bergen's view that these should be treated as a unified phenomenon. But as we will see, the contrast between Brow Raise on *vs.* before an expression raises questions within his analysis. Throughout, we keep our discussion very informal, but refer the reader to the Appendix for a detailed analysis within a very simplified version of Bergen's analysis (with pure rationality in the game-theoretic analysis).

²⁸ A further issue should be noted. When Brow Raise occurs on a non-gradable scalar term, such as *OR*, the present line of analysis leads one to expect that the insertion of an exhaustivity operator will be forced, at least in simple cases. This may initially seem to be a good result: Schlenker et al. 2016 argue that various means of emphasis including Brow Raise can in fact serve to yield an exclusive reading of *OR* in (i)b:

(i) *Context*: Tomorrow there will be a party. The speaker and the addressee make a bet about who will show up.

a. ⁷IX-1 BET ANN_a OR BILL_b COME.

=> if Ann and Bill come and nobody else comes, the speaker wins his bet

b. ⁷IX-1 BET ANN_a $\frac{/\wedge}{_+[\mathbf{OR}]_}$ BILL_b COME.

=> if Ann and Bill come and nobody else comes, the speaker doesn't win his bet

'I bet that Ann or Bill will come.' (ASL, 24, 07; 3 judgments; Schlenker et al. 2016)

To see why exhaustification is expected to be obligatory, let us take the set of alternatives of *A or B* to be just {*A and B*}. The notworthiness requirement is more than half of these formulas fail to entail the disjunction. This couldn't be, since *A and B* entails *A or B*. This would naturally force the insertion of an exhaustivity operator (e.g. Chierchia et al. 2012, Fox and Spector 2018). The target formula would thus become *Exh[A or B]*, with alternatives {*Exh[A and B]*}. Since *Exh[A or B]* is tantamount to an exclusive disjunction, while *Exh[A and B]* is equivalent to [*A and B*], the notworthiness requirement will be satisfied.

While an exhaustified reading is in fact obtained in (ib), we know of no theory that predicts that focus should *force* exhaustification in case focus marking is justified in other ways. For instance, an expected reading of (i) is that I can bet that I'll pass math or physics or both: the focus on *OR* is justified by contrast and shouldn't have to be associated with an exhaustivity operator.

(i) While I wouldn't bet that I'll pass both math AND physics, I can bet that I'll pass math OR physics.

For Brow Raise, our current analysis predicts that exhaustification should be *obligatory*. This would need to be tested and the theory might have to be refined.

7.1 A simplified version of Bergen's analysis

Bergen offers a unified analysis based on the idea that stress serves to reduce the risk of error ('noise') in the transmission of a message. Here we will just summarize the (highly simplified) analysis of two cases: exhaustification as in (1)c, and adjectival strengthening as in (2)a.

Consider the case of *Sam will invite Ann OR Bill*. Bergen's goal is to derive the exclusive (exhaustive) reading by pragmatic means, without positing an exhaustivity operator in the syntax. Bergen's starting point is that there is always a small risk of signal corruption, whereby *or* could be misheard as *and* (the probability may be exceedingly small). One can decrease this risk by stressing the word, yielding a benefit, which we will call *b*. But this comes at a slight cost, which we will call *c*. If the speaker is entirely rational (which isn't the case in Bergen's actual analysis), it's only worth reducing the risk of corruption if the benefit derived in so doing is greater than the cost, i.e. if $b > c$. Now we consider two situations:

Situation 1: the speaker knows that Sam will invite one of {Ann, Bill} but not both.

Situation 2: the speaker doesn't know whether Sam will invite just one or both of {Ann, Bill}.

It is clear that the speaker will consider the risk of misperception of *or* as *and* as being worse in Situation 1, where it provides clearly incorrect information, than in Situation 2, where it might provide correct information. Thus the use of stress will tend to be associated with Situation 1 and for this reason with an exclusive inference akin to exhaustification (whereby *p or q* is strengthened to *p or q but not both*). The listener who takes this into account will thus increase her belief (i.e. her probability) that *or* was used exclusively. And the speaker who takes into account the listener's behavior may thus use stress to signal exhaustification. Formalizing this reasoning requires a detailed analysis within the Rational Speech Act model, as developed by Bergen.

The reasoning is rather similar with adjectival strengthening. Following the literature, Bergen assumes that *tall* and *short* come with contextually determined thresholds, so that *Bob is tall* is deemed true just in case his height is above the height threshold θ . The value of θ is not known with certainty, but it interacts with the speaker's incentive to stress the adjective. Here too, there is a risk that *tall* will be misperceived as *short*, but the risk can be mitigated, with a benefit *b*, in case the speaker stresses the word, and at a cost *c* – which is worth doing if $b > c$. We consider the sentence *Bob is tall*, and we consider once again two situations:

Situation 1: the speaker knows that Bob is very tall, e.g. 1m90.

Situation 2: the speaker knows that Bob is just tall, e.g. 1m75.

In Situation 1, if *tall* gets misperceived as *short*, the addressee will almost certainly form incorrect beliefs, as the threshold for *short* is unlikely to classify 1m90 as short. In Situation 2, the risk that the addressee forms incorrect beliefs is a bit less, because there is a greater chance that the threshold for *short* classifies 1m75 as short. As a result, the benefit of using stress will be a bit greater in Situation 1 than in Situation 2. The listener who takes into account the speaker's behavior will thus tend to associate stress on *tall* with 'very tall' situations. And the speaker who takes into account this behavior on the listener's part will be able to signal that he has in mind a 'very tall' situation by stressing the adjective. Here too, the details, which are complex, are worked out in Bergen 2016 (see our Appendix for a lightly more detailed discussion of the simplified case, however).

7.2 Extending Bergen's analysis to *Brow Raise*

As Bergen 2016 (p. 89) notes, "there are three main acoustic changes associated with prosodic stress: increased loudness, duration, and changes to the fundamental frequency [Breen et al. 2010]. An utterance that is louder and longer is less likely to get swamped by sounds in the environment, while changes in pitch will focus the listener's attention on the utterance." It is clear

that Brow Raise doesn't directly affect the physical risk of a transmission error since the manual message itself doesn't get modified. But it is plausible that Brow Raise might help focus the addressee's attention on part of the message: it might serve as a signal that part of the message has particular value, and hence should be particularly protected from the risk of misperception. This, in turn, would dovetail with Bergen's noise-based analysis. It is worth noting that Bergen's insights can also explain the cluster of properties found when all natural means of emphasis were used in intensificational cases: both (13)b and (15)b thus involve the following form, which involves not just (heightened) Brow Raise, but also a forward lean, a head nod, and increased amplitude. The latter definitely makes the sign more visible, the forward lean might as well, and the head nod might serve to redirect the addressee's attention on the relevant part of the signal.

Bergen's line of analysis can be further strengthened by noting that, in our data, Brow Raise is part of a cluster of properties that includes several other manual or non-manual modifications such as forward lean, greater sign amplitude, and head nod, as discussed above. This can be seen in two ways. First, when the consultant was asked to realize emphasis on a word with all available means, these did not just include Brow Raise, and the result was at least as acceptable as with Brow Raise alone, as can be seen for focus in (7)b, (6)b, (9)b, (11)b, and for intensification in (13)b and (15)b. In particular, the latter two cases involved the following form, with not just heightened Brow Raise, but also a forward lean, a head nod and increased amplitude.

(37) $\int \Delta$
TALL

Second, using these other means to the exclusion of Brow Raise sometimes lead to acceptable results as well: this was the case for focus in (6)c (whereas for reasons we don't understand (7)c was more degraded) and for intensification in (13)c and (15)c. And just as in Bergen's description of the English acoustic facts, some of these means (such as greater sign amplitude) can be taken to help with sign perception, while as mentioned Brow Raise might indicate that the addressee should pay special attention to a certain part of the message. Head nods might fall in the latter category as well, while forward leans might fall in the first category if one thinks that by moving closer to the addressee one is making the sign easier to perceive.

The role of Brow Raise might be viewed in at least two ways. As noted in Section 1.2, Dachkovsky and Sandler argue that it often plays the same role as "high boundary tone in many spoken languages" (Dachkovsky 2005, Dachkovsky and Sandler 2009, Sandler 2011), which in turn might be consonant with Bergen's discussion of the salience-related effect of higher pitch.²⁹ Independently, one could speculate that Brow Raise might be a signal that one's eyes need to be widened, which in turn has been shown to enhance stimulus detection (Lee et al. 2014): this might lie at the source of the signal that the relevant part of the message is particularly important.

Despite these positive results, Bergen's analysis still has a non-trivial question to answer: why is there a contrast between Brow Raise before vs. on an expressions? We can't provide a definitive answer, but we should sketch a direction, mentioned by Leon Bergen (p.c.). The details are developed in the Appendix, but let us summarize the main ideas.

- (i) Brow Raise before an expression is a less efficient way of reducing noise than Brow Raise on an expression (why this is would need to be determined).
- (ii) We assume (with little justification) that Brow Raise before an expression is also less costly than Brow Raise on an expression.
- (iii) Under certain conditions, (i) and (ii) balance each other out and one can thus optionally use Brow Raise on or before an expressions; this is the case of focus-related uses.
- (iv) When the benefit of reducing noise is greater, Brow Raise on an expression wins out; this is the case of intensificational uses.

²⁹ Since tones cannot be realized before a word whereas Brow Raise can, the latter makes it possible to test options that are probably not afforded by high boundary tones.

(v) When the benefit of noise reduction is too low, it does not outweigh the cost of using Brow Raise, and no Brow Raise is used; this is the case expressions that neither involve focus nor intensification.

There are many open questions in this analysis, as is explained in the Appendix, but it could prove very fruitful in the future. Furthermore, on the positive side, Bergen's theory might be better positioned than our alternative-based analysis to explain why heightened Brow Raise can often intensify adjectives when it is preposed. The reason might be that, at little cost, it increases the benefit of the preposed version of Brow Raise, thus making its behavior closer to that of Brow Raise on an expression.³⁰

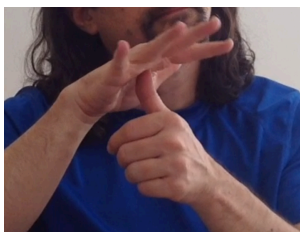
Addressing these fine-grained questions will require a detailed quantitative investigation that is beyond the scope of this paper.

8 Extension: focus and intensification in an ASL iconic construction

We briefly extend our findings to constructions that are highly iconic. We consider a classifier predicate representing a helicopter movement, and show that Brow Raise on a part of the movement can have intensificational uses, but Brow Raise before doesn't lend itself to such an interpretation.

We start from the iconic description of a helicopter movement with a helicopter-denoting classifier predicate, represented in its neutral form in (38). As other classifier predicates (e.g. Emmorey and Herzig 2003, Zucchi 2011), this is a conventional word whose position or movement can iconically represent that of the denoted object. In other words, the lexical form is conventional, but its position or movement is not and yields precise iconic information about the position or movement of the denoted object. In our paradigm, the expression is first introduced in its neutral form, glossed as *HELICOPTER*, with a nominal use ('your helicopter'), before being used as a verbal classifier predicate to represent the helicopter movement, glossed as *HELICOPTER-FLY*.

(38) HELICOPTER classifier predicate



In the paradigm in (39), *HELICOPTER-FLY* traces the path of the helicopter, starting low on the signer's dominant side, ascending and circling, then moving horizontally to the non-dominant side, circling again, before landing. With the standard convention that *a* is on the signer's dominant side and *b* on his non-dominant side, we gloss this iconic movement by way of its four corners as a_{low} $a_{high-stationary}$ $b_{high-stationary}$ b_{low} ; but it should be remembered that this is a continuous movement. The helicopter path is represented by four pictures in (39). The paradigm is then constructed by adding Brow Raise either on or before one of the two circling, stationary parts glossed as $a_{high-stationary}$ and $b_{high-stationary}$. Acceptability judgments pertained to the entire sentence, and inferential judgments, which were subtle, were answered in words rather than by way of multiple choice questions (we write *3/4 judgments*, *4/4 judgments*... when an inference was obtained in 3 out of 4 judgment tasks, in 4 out 4 judgment tasks, etc).

³⁰ Depending on one's assumptions, one might also expect that heightened Brow Raise on a word indicates greater intensification than normal Brow Raise on that same word. This ought to be tested.

- (39) (Acceptability of the entire sentence)
 POSS-2 HELICOPTER IX-1 DON'T-WANT _____.
 'I don't want your helicopter to

^_____

a. ⁷ HELICOPTER-FLY_ a_{low} $a_{high-stationary}$ $b_{high-stationary}$ b_{low} .
 circle [after take-off]_F and before landing.'
 => the signer doesn't want the helicopter to circle right after take-off (4/4 judgments)
 => circling before landing might/would be allowed (3/4 judgments)

}^_____

b. ⁷ HELICOPTER-FLY_ a_{low} $a_{high-stationary}$ $b_{high-stationary}$ b_{low} .
 circle for longer than normal after take-off and circle before landing.'
 => the signer doesn't want the helicopter to circle **for longer than normal** after take-off (4/4 judgments, but in 2/4 judgments with an additional specification: when leaving for another location / if landing is then preceded by circling)
 => limited circling after take-off is permitted (4/4 judgments)

^_____

c. ⁷ HELICOPTER-FLY_ a_{low} $a_{high-stationary}$ $b_{high-stationary}$ b_{low} .
 circle after take-off and [before landing]_F.'
 => the signer doesn't want the helicopter to circle before landing (1/4 judgment) or: after departure and then before landing (3/4 judgments)

^_____

d. ⁷ HELICOPTER-FLY_ a_{low} $a_{high-stationary}$ $b_{high-stationary}$ b_{low} .
 circle after take-off and circle for longer than normal before landing.'
 => the signer doesn't want the helicopter to circle right after take-off and then **circle for longer than normal** before landing (4/4 judgments)

(ASL, [34, 2756](#); 4 judgments)

- (40) Four moments in the representation of the verb tracing the helicopter's path in (39)a

a_{low} $a_{high-stationary}$ $b_{high-stationary}$ b_{low}



While the full inferential judgments (found in the Supplementary Materials) are hard to summarize, two striking points emerge. First, when Brow Raise co-occurs with (rather than precedes) one of the two 'high stationary parts', as in (39)b (= Brow Raise on $a_{high-stationary}$) and (39)d (= Brow Raise on $b_{high-stationary}$), the meaning obtained pertains to *longer than normal* circling (as shown in the boldfaced inferences). Thus Brow Raise affects what is inferred about the duration of the denoted events.³¹ This is probably the same type of intensificational reading as was obtained with Brow Raise co-occurring with gradable expressions in earlier sections.

Second, this intensificational reading disappears when Brow Raise is brief and precedes the 'high stationary parts', as in as in (39)a (= Brow Raise right before $a_{high-stationary}$) and (39)d (= Brow Raise right before $b_{high-stationary}$). In (39)a, we just obtain a reading on which, in the relevant circumstances, circling after take-off is disallowed, with an implication that circling before

³¹ It would be important in the future to assess more precisely the duration of the relevant part of the manual sign.

landing might be allowed. Everything happens as if the particular sequence displayed is disallowed, but with an implicature that an identical sequence without circling after take-off (but with circling before landing) would be allowed. This can be explained if the iconic sign with Brow Raise evokes alternatives obtained by replacing the focused part with some salient expressions, as shown in (41). It is then implicated that although the path as shown is disallowed, an alternative to it displayed by a member of that set is allowed, hence the result.

- (41) Formal alternatives to $a_{low} \wedge \neg [a_{high-stationary}] b_{high-stationary} b_{lo}$
 $Alt(a_{low} \wedge \neg [a_{high-stationary}] b_{high-stationary} b_{lo}) = \{a_{low} \pi b_{high-stationary} b_{low} : \pi \text{ an alternative to } a_{high-stationary}\}$

For reasons we do not understand, the inferences obtained are more complex in (39)d, but there too it is clear that the 'longer than normal' reading obtained in (39)c does not arise.

If the iconic path of the helicopter is considered as one sign, these results show that focus and intensification can apply at the sublexical level. For focus, this point was made about spoken language by Artstein 2004 in connection with sentences such as (42).

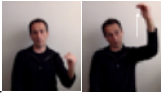
- (42) John only brought home a stalagMITE from the cave.

As Artstein writes, "here prominence on the syllable *mite* serves to indicate the restriction on the domain of *only*, in a manner similar to focus on words and higher constituents. The location of prominence thus has an effect on the sentence's truth conditions: the sentence implies that John did not bring home a stalactite, but does not say anything about what else he might have brought". A similar point is made by (39)a and (39)c. In addition, (39)b and (39)c suggest that intensification too can be applied at the sublexical level.

The paradigm in (39) makes points not made by Artstein's data. First, sub-lexical focus can apply to iconic constructions. This observation highlights the degree to which iconic meanings are integrated with the rest of sign language semantics and pragmatics. The repercussions of the existence of iconic intensification have yet to be explored. The possibility of sublexical focus in iconic constructions suggests that any theory of focus-related alternatives must make provisions for alternatives to iconic representations, as was sketched in (41).

This result might dovetail with work on iconic gestures: Schlenker 2019 discusses implicatures triggered by speech-replacing ('pro-speech') gestures such as those in (43).

- (43) a. Robin isn't VERY-BIG 
 => Robin is big

- b. Robin isn't VERY-TALL 
 => Robin is tall
 (Schlenker 2019)

These examples are in one respect similar to our helicopter path sentences: they are iconic, and they evoke alternatives that are not explicitly mentioned in the preceding discourse.³² Specifically, Schlenker 2019 suggests that the alternatives evoked are obtained by replacing *VERY-BIG* and *VERY-TALL* by the sub-gestures representing just *BIG* and *TALL*. By standard Gricean reasoning, the alternatives *Robin isn't BIG* and *Robin isn't TALL* are understood to be denied,

³² Tieu et al. 2019 provide experimental results on gestural implicatures, but in all their cases the alternatives are mentioned in the preceding discourse.

hence the inference that Robin is big or tall, as the case may be. Here too, a theory of iconic alternatives is crucial.³³

Finally, Brow Raise co-occurring with the 'circling' parts of the path might be an instance of a sublexical intensification, which should be of interest in its own right.

9 Conclusion

9.1 Results and limitations

It goes without saying that our generalizations should be tested within further consultants, both in ASL and LSF (our LSF data were particularly preliminary, since we just argued that there are some cases that replicate our main ASL generalizations); further examples should be investigated, especially in cases in which our paradigms were not as minimal as we had hoped. Still, we have arguably obtained the following results.

1. Brow Raise doesn't just have information-theoretic uses in ASL and LSF; in our data, it can also serve to intensify gradable constructions. This can be seen as an argument for the claim in Bergen 2016 that focus and intensification should be derived from the same mechanism.
2. While Brow Raise on an expression is ambiguous, normal Brow Raise *before* an expression lacks the intensificational reading. But heightened Brow Raise gives rise to some intensificational reading when it comes before an expression.
3. An analysis can be developed within Alternative Semantics on the assumption that (i) Brow Raise on an expression (but not before one) can focus-mark a degree variable, and (ii) Brow Raise makes a semantic contribution of its own ('noteworthiness'). It requires stipulations, and it doesn't capture the fact that heightened Brow Raise before an expression can yield intensificational readings.
4. An alternative can be developed within the noise-reduction-based analysis of Bergen 2016, but it would need to account for the fact that Brow Raise before an expression fails to yield intensification. While there are possible explanations, their evaluation will have to await a detailed quantitative analysis.
5. In our ASL data, the same generalizations arguably apply to Brow Raise appearing within highly iconic constructions: it can thus focus or intensify a subpart of an iconic representation.

9.2 Future directions

Besides being tested with further consultants, our investigation ought to be extended to further cases of emphasis-based intensification discussed by Bergen 2016, notably exhaustification as in (1)c and effects on quantifier domain restriction in (2)b.

On a theoretical level, neither theory considered in this piece is entirely explanatory as things stand. In particular, we crucially posited that focus semantics is combined with a 'noteworthiness' component that was stipulated for present purposes, and the alternative within

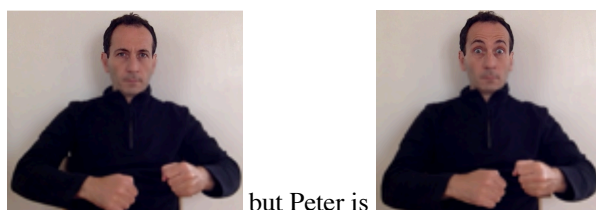
³³ Schlenker 2019 speculates on a more subtle point: the more complex gestures *VERY-BIG* and *VERY-TALL* seem to evoke, even in the absence of context, the sub-gestures *BIG* and *TALL*, but the converse might not hold. If so, this argues for the extension to the iconic case of an asymmetry derived by Katzir 2007: more complex expressions automatically evoke less complex ones, but the converse doesn't hold. This asymmetry is illustrated in (i), where the more complex expression *drink a lot* evokes the less complex expression *drink* (hence the implicature in (ib), but not conversely (hence the absence of an implicature in (ia)).

- (i) a. I drank.
 ⇒ I didn't drink a lot
 b. I didn't drink a lot.
 ⇒ I drank

Bergen's framework has yet to be fully developed for the case at hand. We have not considered further potential theories, such as the view that intensification Brow Raise on an expression might be a completely different phenomenon, for instance an instance of iconic modulation (e.g. as discussed in Schlenker 2018). This could immediately explain why Brow Raise before an expression fails to have the same interpretation. But this view would face non-trivial difficulties, notably (i) the fact that intensificational Brow Raise is part of the same cluster of properties that mark focus constructions, and (ii) the fact that heightened Brow Raise before an expression can to some extent fulfill an intensificational function.

Several important extensions could be considered in the future.

1. Eyebrow raising is known to mark focus in spoken language (e.g. Doherty 2005, Doherty and Loevenbruck 2009). Can it have intensificational uses as well? We conjecture that this is the case, at least when it appears on a pro-speech gesture, as in (44). We conjecture that the second gesture, with eyebrow raising, lends itself to a meaning akin to 'very big', even when the manual gesture is kept constant.



(44) John is  but Peter is .

Ideally, one would want a detailed study of the focus- and intensification-related uses of Brow Raise on pro-speech gestures (i.e. on gestures that fully replace some words). Since the effects of Brow Raise are typically subtle, this would license a separate study.

2. Is there a broader generalization to be drawn to the effect that intensificational emphasis must be realized on an expression whereas informational focus can be realized before one? One could explore the behavior of pauses to mark an expression as focused, as in (45).

(45) I only introduced Ann to... Bill.
=>? I didn't introduce other people than Ann to Bill

The question is twofold: (i) can association with focus and contrastive focus be realized in this way? (ii) can intensificational uses be produced with gradable constructions? While (i) requires more work, our impression is that (ii) should receive a negative answer: we believe that an intensificational reading of the second adjective is extremely difficult in (46)b, unlike (46)a.

(46) a. John is tall, but Peter is TALL.
b. #John is tall, but Peter is... tall.

Here too, the data are bound to be subtle and to require a separate study.

Appendix. A simplified noise-based analysis

We revisit in greater detail the prospects for a noise-based analysis of our data, following in greatly simplified form the spirit of Bergen 2016. We depart from the letter of his proposal along several dimensions: (i) we focus the discussion on the case in which the speaker and addressee are entirely rational; (ii) we do without Questions under Discussion ('QUDs'), which play an important role in Bergen's technical analysis; (iii) we do not derive the utility of different actions from the information they transmit.

We consider two highly simplified cases: contrastive focus (= (47)a) and intensificational emphasis (= (47)b).

(47) a. Contrastive focus, as in (7)

Today I have several meetings. My first meeting is with Ann, Charles, Edith and Denis, then [I met] with Ann, Bill/BILL, Edith and Denis.

Possible realizations: $\overset{\wedge}{\text{BILL}}$ $\overset{\wedge}{\text{BILL}}$ (also written as $\overset{\wedge}{\text{BILL}}$ and $\overset{\wedge}{\text{-BILL}}$ respectively)

b. Intensificational emphasis, as in (21)

I want you to drive near / NEAR.

Possible realizations: $\overset{\wedge}{\text{NEAR}}$ (also written as $\overset{\wedge}{\text{NEAR}}$)

□ Main assumptions

The key idea is that words have a small chance of being misperceived, but that emphasis can, at some cost, mitigate this risk. We will consider three situations depending on how deleterious the misperception is: cases where the error is 'strong', 'medium', and 'weak' (we will see below how these map to cases we consider in this piece). Pay-off when the message is well transmitted is 3. When a 'strong' error is made, pay-off is 0; when a 'medium' error is made, pay-off is 1; when a 'weak' error is made, pay-off is 2. Importantly, we assume that Brow Raise on a word fully eliminates the risk of noise (no error is made), while Brow Raise before a word is less effective (errors happen with probability p_1). When no Brow Raise is used, errors happen as well, with a greater probability (p_2). To clarify where we are going, we write below (48) what the winners will turn out to be if we are to explain the generalizations illustrated in (47): $\overset{\wedge}{\text{WORD}}$ should win in situations of 'strong error' (which pertain to situations of intensification), $\overset{\wedge}{\text{WORD}}$ and $\overset{\wedge}{\text{-WORD}}$ should be joint winners in situations of 'medium error' (which pertain to focus), and WORD should be the sole winner in situations of weak error (which pertain neither to focus nor to intensification).

(48) Outcomes of noise affecting a word depending on whether it is produced as WORD , $\overset{\wedge}{\text{-WORD}}$ or $\overset{\wedge}{\text{WORD}}$

	Cost	Probability	Perceived word	Pay-offs: situations of strong/medium/weak error	Utility = expected pay-off - cost		
					Strong error	Medium error	Weak error
WORD	0	p_2	wrong	0 / 1 / 2	$3(1-p_2)$ = $3-3p_2$	$3(1-p_2)+p_2$ = $3-2p_2$	$3(1-p_2)+2p_2 =$ $3-p_2$
		$(1-p_2)$	right	3			
$\overset{\wedge}{\text{-WORD}}$	c_1	p_1	wrong	0 / 1 / 2	$3(1-p_1)-c_1$ = $3-3p_1-c_1$	$3(1-p_1)+p_1-c_1$ = $3-2p_1-c_1$	$3(1-p_1)+2p_1-c_1$ = $3-p_1-c_1$
		$(1-p_1)$	right	3			
$\overset{\wedge}{\text{WORD}}$	c_2	1	right	3	$3-c_2$	$3-c_2$	$3-c_2$

Intended winners	$\overset{\wedge}{\text{WORD}}$	$\overset{\wedge}{\text{-WORD}}$ $\overset{\wedge}{\text{WORD}}$	WORD
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□ *Analysis with pure rationality*

To keep things maximally simple, we analyze the behavior of a purely rational speaker that takes into account the outcomes in (48). We wish to distinguish between three situations: one in which \hat{WORD} is the sole winner, as for adjectival intensification; one in which \hat{WORD} and $\hat{-WORD}$ are both winners, as for contrastive focus; and one in which $WORD$ is the sole winner, as for unfocused, unintensified words.

Now we note that global utility for \hat{WORD} is constant across utility columns (it is stable at $3-c_2$), while all the other values diminish on each line as one goes from right ('weak error') to left ('strong error'). This entails that if \hat{WORD} is the sole winner (= sole utility-maximizing form) in one column, it is as well in columns to the left; and that if \hat{WORD} is non-optimal in one column, it is as well in columns to the right. The only way to distinguish our three targets is thus for \hat{WORD} to be the winner in the left-most column, for $WORD$ to be winner in the right-most column, and for \hat{WORD} and $\hat{-WORD}$ to be joint winners in the intermediate column.

We now derive the conditions under which the winners are indeed as intended.

(i) Since \hat{WORD} and $\hat{-WORD}$ are joint winners in the intermediate column, they must give rise to the same utility, which is captured by the equation in

$$(49) \quad 3-2p_1-c_1 = 3-c_2, \text{ i.e.} \\ c_2 = c_1 + 2p_1$$

This result can be interpreted as follows: in situations of medium error, $\hat{-WORD}$ leads to the same pay-offs as \hat{WORD} when the message is correctly transmitted, but in proportion p_1 of the cases, $\hat{-WORD}$ is responsible for an error that delivers pay-off 1 instead of the pay-off 3 delivered by \hat{WORD} , hence a pay-off difference of 2. For \hat{WORD} and $\hat{-WORD}$ to be equally beneficial despite this different, the cost difference between them must be $2 \cdot p_1$, as stated in (49). This is a non-trivial requirement, as it entails that the cost of \hat{WORD} must be greater than that of $\hat{-WORD}$. One could try to motivate this by the assumption that *Brow Raise* before a word can be shorter than *Brow Raise* on a word, but it isn't clear that this is correct.

We note for future reference that from (the first line of) (49), the inequalities in (50) follow as well.

$$(50) \quad 3-3p_1-c_1 < 3-c_2 (= 3-2p_1-c_1) < 3-p_1-c_1$$

(ii) In the intermediate column, \hat{WORD} (and hence $\hat{-WORD}$, following (i)) win over $WORD$ and must thus yield greater utility, which is expressed in the inequality in (51).

$$(51) \quad 3-c_2 > 3-2p_2, \text{ i.e.} \\ c_2 < 2p_2, \text{ i.e. (in view of (49))} \\ c_1 + 2p_1 < 2p_2, \text{ i.e.} \\ c_1 < 2(p_2-p_1)$$

(iii) In the right-most column, $WORD$ should be the winner and should thus produce greater utility than either \hat{WORD} (utility $3-c_2$) or $\hat{-WORD}$ (utility $3-p_1-c_1$). Since by (50) $3-c_2 < 3-p_1-c_1$, this boils down to a requirement that the utility of word should be greater than $3-p_1-c_1$, as is expressed in (52).

$$(52) \quad 3-p_2 > 3-p_1-c_1, \text{ i.e.} \\ p_2-p_1 < c_1$$

(iv) In the left-most column, \hat{WORD} should be the winner and should thus produce greater utility than either $WORD$ or $\hat{-WORD}$. It follows from (50) that \hat{WORD} (with utility $3-c_2$) produces greater utility than $\hat{-WORD}$ (with utility $3-3p_1-c_1$), so we are left with the condition in (53):

- (53) $3-c_2 > 3-3p_2$, i.e.
 $c_2 < 3p_2$, i.e. (in view of the equality in (49))
 $c_1 + 2p_1 < 3p_2$, i.e.
 $c_1 < 3p_2 - 2p_1$

But this result already follows from (51) because $c_1 < 2(p_2-p_1) = 2p_2 - 2p_1 < 3p_2 - 2p_1$.

In the end, we are left with the following conditions:

- (54) a. $c_2 = c_1 + 2p_1$
 b. $p_2-p_1 < c_1 < 2(p_2-p_1)$

This is for instant satisfied by the following parameters (dividing all values by an arbitrary positive number would work just as well):

- (55) $p_1 = .2$
 $p_2 = .4$
 $c_1 = .3$
 $c_2 = c_1 + 2p_1 = .3 + .4 = .7$

It can be checked in (56) that the utilities resulting from (55) indeed guarantee that in case a misperception causes strong damage, ^WORD will be used, in case it causes medium damage, ^WORD and ^-WORD will be tied, and in case it causes weak damage, WORD will win.

- (56) Utilities derived from (48) with the parameters in (55) (maximal utilities in a given column are **boldfaced**)

	Cost	Probability	Perceived word	Pay-offs: situations of strong/medium/weak error	Utility = expected pay-off - cost		
					Strong error	Medium error	Weak error
WORD	0	p_2	wrong	0 / 1 / 2	$3-3p_2 = 3 - 1.2 = 1.8$	$3-2p_2 = 3-.8 = 2.2$	$3-p_2 = 3-.4 = 2.6$
		$(1-p_2)$	right	3			
^-WORD	c_1	p_1	wrong	0 / 1 / 2	$3-3p_1-c_1 = 3-.6-.3 = 2.1$	$3-2p_1-c_1 = 3-.4-.3 = 2.3$	$3-p_1-c_1 = 3-.2-.3 = 2.5$
		$(1-p_1)$	right	3			
^WORD	c_2	1	right	3	$3-c_2 = 3-.7 = 2.3$	$3-c_2 = 3-.7 = 2.3$	$3-c_2 = 3-.7 = 2.3$

□ Interpretation

Do these results make sense? We must discuss (i) the constraints on the parameters obtained in (54), and (ii) the mapping between situations of focus and intensification and the columns in (48).

Concerning (i), the most easily interpretable result is the requirement $c_2 = c_1 + 2p_1$ (= (54)a), from which it follows that the cost c_2 of ^WORD should be greater than the cost c_1 of ^-WORD. This requirement is due to the fact that ^WORD and ^-WORD must be tied in some cases, and ^-WORD is a less efficient way to reduce noise, hence it must also be cheaper. It's unclear whether the cost difference is intuitively correct, however: why would *Brow Raise* be less costly to realize before than on an expression? One could argue that it is in that case briefer, but that remains to be seen. The requirement in (54)b would need to be interpreted as well.

Concerning (ii), we need to have the following categorization of situations:

1. Strong error = misperceiving *NEAR* for *FAR* in a situation in which the intended meaning is *very near*, as in (47)b.

2. Medium error = misperceiving *BILL* for *JOHN* in a situation in which *BILL* is contrastive, as in (47)a.

3. Weak error = misperceiving *NEAR* for *FAR* in a situation in which the intended meaning is *near*, or misperceiving *BILL* for *JOHN* when *BILL* is not contrastive.

The contrast between (1) and (3) for *NEAR* is justified by Bergen 2016 as follows: when the intended meaning is 'very near', there is a greater chance that the addressee will derive incorrect information from the misperceived utterance (with *FAST* in lieu of *NEAR*) than when the intended meaning is 'near' (because in 'near' situations, some values of the contextual threshold might still treat them as falling under the term *FAR*). Conceptually, things are similar for non-contrastive *BILL*, as conveying information to the effect that *John* came might not contradict the fact that Bill did.³⁴ But several questions are open at this point:

–Why is misperception of contrastive *BILL* worse than misperception of non-contrastive *BILL*?
 –If association with *ONLY* gives rise to optionality between Brow Raise before vs. on a word, why does it fall in category (ii) rather than (i)?

Going forward, more fine-grained questions would be important as well.

–Heightened Brow Raise before a word could, in our data, fulfill some of the functions of Brow Raise on a word. This would make sense if heightening Brow Raise increases its effectiveness (without increasing the cost too much), thus compensating the reduction due to pre-word placement.

–It would also be interesting to determine whether heightened Brow Raise on a scalar terms intensifies it more than normal Brow Raise on the same term. This is what this general model would lead one to expect.³⁵

□ *Less simplified models*

The model discussed by Bergen 2016 is far more sophisticated than the one discussed here along different dimensions: (i) it derives pay-offs from the amount of information transmitted; (ii) in some cases, it crucially relies on a Question under Discussion; (iii) it considers reasoning with bounded rationality, in which agents do not just go for the optimal choice but come up with a probabilistic mix that depends on the pay-offs.

To illustrate the importance of the last point, consider the example in (57). When *TALL* is produced, there is a systematic error and it is perceived as *SHORT*. Pay-offs represent probabilities that the addressee assigns to the world the speaker is in. In the spirit of Bergen's analysis, this probability is null if the world is one in which John is very tall and *SHORT* is perceived, while this probability is 1/4 if the world is one in which John is medium tall (because due to vagueness *SHORT* has a chance of being true of the world in which John is medium tall). When [^]*TALL* is used, the message is transmitted correctly, and the addressee infers with equal probability that she is in the 'very tall' and in the 'medium tall' world.

(57) Addressee's probabilities (which are also the speaker pay-offs) in a situation with just one possibility of intensification and systematic corruption of the unintensified message

	'Very' tall world: John is very tall	'Medium' tall world: John is medium tall
TALL (systematic error: perceived as SHORT)	0	1/4
[^] TALL	1/2	1/2

³⁴ Bergen handles in this fashion exclusive vs. non-exclusive readings: *BOB went to the store* tends to be associated with an exclusive reading because, when the Question under Discussion is *Who went to the store?*, misperceiving *Bob* as *Alice* would be catastrophic, yielding an inference ('only Alice went to the store') that is incompatible with the facts. By contrast, when the Question under discussion is *Did Bob go to the store?*, mishearing *Bob went to the store* as *Alice went to the store* would be less deleterious, as the following is still compatible with the facts.

³⁵ It seems plausible to us that such gradient effects arise in spoken language. Take the following discourse. *Sam is TALL. And Robin is TALL.* With greater intensification on the second occurrence of *tall* than on the first, it seems plausible to us that one can derive an inference that Robin is taller than Sam.

It is clear that if the speaker just picked the message leading to the highest pay-off, *Brow Raise* would be used in all cases. But now assume instead that the speaker S_1 adopts a probabilistic strategy, using each form in proportion to the pay-offs it yields. This yields the strategy in (58), which should be read by column: in the 'very tall' world, only \hat{TALL} is used. In the 'medium tall' world, \hat{TALL} is used $2/3$ of the time, i.e. around 67% of the time.

(58) Strategy of the strategic speaker S_1 , to be read by column: proportion of use of the competing forms in each situation.

	'Very' tall world: John is very tall	'Medium' tall world: John is medium tall
TALL (systematic error: perceived as SHORT)	0	1/3
\hat{TALL}	1	2/3

Now we consider the addressee A_1 who takes into account the strategy of the speaker S_1 summarized in (58). Because the message is systematically corrupted, we assume for simplicity that the pay-offs do not change for the line in which *TALL* is produced, as shown in the first line of (60). As for the line in which \hat{TALL} is produced, we assume that the strategic listener L_1 takes into account S_1 's strategy to infer which world she is in, using Bayes's rule. Thus the probability that the world is 'Medium tall', in which John is medium tall, is obtained as in (59). We assume that the listener's base probability that John is very tall and that John is medium tall is initially the same, and we call it π (we assume throughout that *TALL* and \hat{TALL} are not used in worlds not represented here).

$$\begin{aligned}
 (59) \quad P(\text{Medium} \mid \hat{TALL}) &= \frac{P(\text{Medium}) P(\hat{TALL} \mid \text{Medium})}{P(\text{Very}) P(\hat{TALL} \mid \text{Very}) + P(\text{Medium}) P(\hat{TALL} \mid \text{Medium})} \\
 &= \frac{\pi P(\hat{TALL} \mid \text{Medium})}{\pi P(\hat{TALL} \mid \text{Very}) + \pi P(\hat{TALL} \mid \text{Medium})} \\
 &= \frac{P(\hat{TALL} \mid \text{Medium})}{P(\hat{TALL} \mid \text{Very}) + P(\hat{TALL} \mid \text{Medium})} \\
 &= \frac{2/3}{1+2/3} \\
 &= (2/3) / (5/3) = 2/5
 \end{aligned}$$

(60) Strategy of the addressee A_1 , to be read by row: probability inferred for each world upon perceiving a signal

	'Very' tall world: John is very tall	'Medium' tall world: John is medium tall
TALL (systematic error: perceived as SHORT)	0	1/4
\hat{TALL}	3/5	2/5

Still taking the speaker's pay-off to be in proportion to the probability that the addressee assigns to the 'right' world, we see that \hat{TALL} yields a slight lower pay-off relative to *TALL* in the Medium world in (60) than in (57), since $2/5$ (= the pay-off in (60)) is less than $1/2$ (= the corresponding pay-off in (57)).

The strategic speaker S_2 who takes into account A_1 's behavior will have the strategy in (61), where the proportions of use in the last column are given the proportion of the pay-offs in

(60): in world Medium, S_2 uses \hat{TALL} in proportion $(2/5) / (1/4 + 2/5)$, i.e. $(2/5) / ((5+8)/20)$, which simplifies to $8/13$, i.e. 61% of the time, which compares with the 67% of strategic speaker S_1 in (58).

(61) Strategy of the strategic speaker S_2 , to be read by column: proportion of use of the competing forms in each situation.

	'Very' tall world: John is very tall	'Medium' tall world: John is medium tall
TALL (systematic error: perceived as SHORT)	0	5/13
\hat{TALL}	1	8/13

What we see, then, is that despite the fact that \hat{TALL} has a systematic advantage in (57), this advantage is even greater in the 'very tall' than in the 'tall' situation, with the result that as one goes higher in the strategic reasoning, one gets an increasing association of \hat{TALL} with the 'very tall' situation, and correspondingly a decreasing association of \hat{TALL} with the 'medium tall' situation. Thus bounded rationality makes it possible to relax the demanding relations among costs and benefits in our initial analysis. This is one of the subtleties that ought to be discussed in a full analysis in the future.

Supplementary Materials: Raw Data

An Excel files with the raw quantitative scores and averages can be downloaded at the following URL (averages have normally been underlined when there was more than a 2-point difference among the averaged numbers)

<https://drive.google.com/file/d/1GBY1ro6jyXRXy1JS4SLpgpSrn3HCcvsi/view?usp=sharing>

Raw ASL and LSF data can be downloaded in .docx format at the following URL:

<https://drive.google.com/file/d/1wpRZSJ0Sp8IhrzU4f-ewlJ5eiwc1BQr0/view?usp=sharing>

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