Why *more* and *less* are never adverbs

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1. Introduction

Geoff Pullum's career has been characterized by meticulous reevaluations of established linguistic conventions on a remarkably broad range of topics from the philosophical basis of linguistics to the rigorous categorization of individual words (e.g., Huddleston & Pullum (2002), Payne et al. (2007, 2010)). In a similar spirit of reevaluation, I argue that *more* and *less* are always determinatives, contrary to the categorization in *The Cambridge grammar of the English language* (Huddleston & Pullum 2002).

CGEL holds that while *more* and *less* are generally determinatives, they are adverbs exceptionally in the context of analytic comparatives, such as in *more interesting* or *less quickly*. The justification for this categorization is that analytic *more* "does not enter into any [degree modifier] contrast with *much*: we can say *This is more porous than that*, but not **Is this much porous?*" (Huddleston & Pullum 2002: 1123).

This paper challenges that claim, arguing that such contrasts do in fact exist. I propose that the distributional facts can largely be explained by the semantics of *–er*/*more* and *much*. Specifically, following Zhang & Ling (2021), I adopt the position that *–er*/*more* establishes a salient minimum value in the discourse (Zhang & Ling 2021) where none might otherwise exist. And following Kennedy & McNally (2005), I argue that *much* requires such a value in order to function as a modifier. This semantic interplay between *–er*/*more* and *much* provides a pragmasemantic explanation for their distribution, without needing to posit a category distinction.

Furthermore, I argue that a mere lack of contrast should not be relied upon for making categorial determinations in any case, following the arguments by Payne et al. (2010). For these reasons, positing two different lexemes for *more* and *less* is neither necessary nor parsimonious. The determinative analysis can account for all of the relevant data.

The paper is structured as follows: Section 2 lays out *CGEL*'s analysis of *more* and *less* and the notion of analytic comparatives. Section 3 presents contrasts between *more*/*less* and *much*/*little* in various syntactic contexts, challenging *CGEL*'s empirical claim. Section 4 examines the complex factors influencing the distribution of degree modifiers and argues that *more* and *less* do not pattern distinctly from other determinatives. Section 5 proposes a semantic explanation based on scale structure for the distributional patterns observed. Finally, Section 6 argues against relying on distributional complementarity for making categorial

distinctions, before the paper concludes in favor of a unified determinative analysis of *more* and *less*.

2. *CGEL* Analysis

This section introduces the *CGEL* framework that are essential for understanding the subsequent analysis.

2.1. Terminology

CGEL (24) distinguishes between lexical and phrasal categories on one hand and syntactic functions on the other. The lexical category of a word is what you would find in the dictionary – its part of speech. Phrasal categories are derived from these lexical categories. Syntactic functions, in contrast, are relational notions. For example, *happy* is always and only a member of the adjective category, but the adjective phrase (AdjP) *very happy* can function as a modifier in *a very happy child* or as a predicative complement in *the child is very happy*.

I argue that the lexemes *more* and *less* belong to the lexical category of DETERMINATIVE. In *CGEL*, determinatives include articles, demonstratives, cardinal numbers, universals such as *all* and *both*, and a few other items. These elements head determinative phrases (DPs), which should not be confused with the notion of a "determiner phrase" in the DP hypothesis. Perhaps surprisingly, *CGEL* and Chomsky (2020) agree on this point: the widely accepted DP hypothesis is mistaken, despite its prevalence in generative syntax. In this paper, a phrase like *far fewer* is analyzed as a DP, while a phrase like *this word* is considered an NP.

The main syntactic function that DPs perform is the DETERMINER function in NPs (e.g., *every change*). But this is a many-to-many relationship: DPs serve other functions as well, such as MODIFIER in AdjPs (e.g., *this happy*). Conversely, other constituents besides DPs – primarily NPs – can also function as determiners in NPs (e.g., *the group's output*).

2.2. CGEL's analysis of more *and* less *as adverbs*

CGEL (539) analyzes *more* and *most* as inflected forms of the determinative *much*, and similarly *less* and *least* as inflected forms of *little*, with one exception: in analytic comparatives they are considered adverbs ($more_{a}$, $less_{a}$). *CGEL* states: "For the comparative category, analytic marking is by means of the adverb *more*" (1123), and extends this analysis to $most_{a}$, $less_{a}$, and $least_{a}$ (64). This adverb classification is not due to their role as degree modifiers (395, 459, 549), since *CGEL* notes that "Apart from the interrogatives and relatives, virtually all determinatives that can occur in NP structure with a non-count singular head can also function as modifier to verbs and/or adjectives and adverbs" (565). Rather, it hinges specifically on the claim that *more* fails to enter into any degree modifier contrast with *much* in this environment.

> *Much* and *little* (all forms) occur as degree adjunct in clause structure: *Jill little realised what they were planning*; *It didn't hurt as much as last time*. The plain forms *much* and *little* modify comparative expressions: *much better*, *little different*, *much more cheese*, *little less intrusive*. *Very much* modifies a wider range of expressions: *very much in control*, *very much an intellectual*. (*More* and *less* modify adjectives, adverbs, etc., but we take these to be degree adverbs, rather than comparative forms of *much* and *little*: see Ch. 13, §4.1.1.). (*CGEL* 395)

Notably, *more* and *less* are the only determinatives in *CGEL* that are argued to be homonymous with adverbs. In categorizing them as adverbs in analytic comparatives, *CGEL* aligns with the long tradition in English grammars and dictionaries. For example, this is the position taken by Quirk et al. (1985: 463) and the *Oxford English Dictionary*. Payne et al. (2010: 37) define the "distributional core" of adverbs as follows:

> Any item which can appear after a subject and before a verb (and does not by other distributional criteria belong to another category) will be adjudged to belong to the adverb distributional core.

Although rarely, *more* and *less* do meet this criterion, as in (1).

(1) (a) I more danced than walked my way back.
(b) I less walked than danced my way back.

However, *CGEL* analyzes such cases as containing determinatives, diverging from the traditional adverb analysis (534). The adverb categorization is applied specifically to analytic comparative constructions. In the following sections, I argue that this restricted dual categorization is unmotivated, and that a unified determinative analysis is preferable.

2.3. Analytic comparatives

The term ANALYTIC COMPARATIVE refers to a construction where "separate words realize grammatical distinctions that in other languages [or in other contexts in the same language] may be realized by inflections" (Matthews 2003). While *CGEL* restricts its discussion of analytic comparatives to AdjPs and AdvPs as in (2; 533), it's worth considering other possible analytic comparative constructions.

(2) (a) no more interesting than before [AdjP]
(b) no more quickly than before [AdvP]

There are clearly gradable PPs which allow comparative forms, either inflectionally as in *closer to home* or analytically as in (3a). These would seem to qualify as analytic comparatives. VPs and NPs like (3b & 3c) appear structurally quite similar, but lack inflectionally comparative counterparts in English, so it may be inappropriate to consider them true analytic comparatives.

(3) (a) no more like it than before [PP]

(b) no more enjoy it than before [VP]

(c) no more food than before [NP]

Interestingly, while *CGEL* explicitly analyzes *more* and *less* as determinatives in PPs like *more out of sorts* (395, 533), it does not extend the adverb analysis to these clear cases of PP-based analytic comparatives. This seems like an inconsistency, especially since the lack of contrast with *much* that *CGEL* uses to justify the adverb categorization applies here as well.

2.4. *Summary of the CGEL analysis*

In summary, while *CGEL* generally analyzes determinatives as being able to modify a wide range of phrase types without exhibiting homonymy with adverbs, it makes an exception for *more* and *less* in analytic comparative AdjPs and AdvPs, though not PPs. The sole basis given for this dual categorization is the claim that *more* fails to contrast with *much* in these environments.

In the following sections, I demonstrate that such contrasts do in fact occur, even in AdjPs and AdvPs. For the remainder of this paper, I focus primarily on *much* and *more*, but the general argument applies equally to *less* and *little*.

3. CONTRASTS IN VARIOUS CONTEXTS

This section presents evidence of contrasts between *much* and *more* in various syntactic environments, challenging *CGEL*'s claim that such contrasts never occur in analytic comparatives.

3.1. *Contrasts in AdjPs with plain-form heads*

To identify which adjectives head AdjPs that allow modification by *much*, I searched the Corpus of Contemporary American English (COCA, from which all examples are taken unless otherwise specified; Davies 2008–).[1] The query `[be] much JJ` returns hits for all forms of *be* (e.g., *is*, *were*, *being*) followed by *much* plus an adjective, excluding negated forms like *isn't*. As expected, the results are dominated by comparative adjectives, but some plain-form adjectives also appear.[2] Similar searches with `[seem] much JJ` and `[become] much JJ` produce the set of adjectives in Table 1. I then searched for each of these adjectives preceded by *be*/*seem*/*become* + *more* (e.g., `[be] more akin`). The resulting frequencies are shown in Table 1.

Strikingly, *much* not only modifies plain-form adjective heads in these AdjPs, but sometimes does so more frequently than *more* (e.g. with *different*). Moreover, despite *much* being a negative polarity item (NPI) in many contexts, it exhibits little polarity sensitivity

[1] COCA (https://www.english-corpora.org/coca/) was 1,002,889,754 words when the data was collected, in late 2023, including 24–25 million words each year from 1990–2019.

[2] Tagging errors (e.g., *much good* tagged as a noun), determiner uses of *much* (e.g., *much recent investment*), and clear errors like **men are much likely to be bloggers than women* were excluded.

with the adjectives in Table 1. The distribution of *much* is even broader when it is itself modified (e.g., *very/as/pretty much equal*; Huddleston & Pullum 2002: 827).[3]

Table 1
The counts of all words tagged as adjectives in COCA heading AdjPs modified by *much* and *more* in complement function for any form of *be*, *seem*, or *become*, along with the ratio of *much*:*more* tokens.

WORD	*much*	*more*	RATIO	WORD	*much*	*more*	RATIO
like[a]	955	9458	0.10	*dependent*	4	253	0.02
different	841	482	1.74	*perplexed*	4	7	0.57
improved	239	2	119.50	*preoccupied*	4	59	0.07
interested	74	3,207	0.02	*annoyed*	3	58	0.05
concerned	44	2,703	0.02	*worried*	3	735	0.00
alike[a]	30	166	0.18	*appreciative*	3	51	0.06
anticipated	25	5	5.00	*alive*	3	108	0.03
beloved	18	11	1.64	*available*	2	178	0.01
surprised	18	228	0.08	*dismayed*	2	6	0.33
preferable	17	13	1.31	*dissatisfied*	2	17	0.12
pleased	17	154	0.11	*important*	2	9,931	0.00
superior	15	14	1.07	*essential*	2	76	0.03
involved	15	919	0.02	*aggrieved*	1	1	1.00
indebted	12	3	4.00	*profitable*	1	301	0.00
inferior	10	3	3.33	*impoverished*	1	3	0.33
hard[b]	9	30	0.30	*guilty*	1	29	0.03
afraid	9	315	0.03	*familiar*	1	632	0.00
akin	8	306	0.03	*interesting*	1	1,125	0.00
aware	7	1,256	0.01	*flawed*	1	4	0.25
amused	6	43	0.14	*tired*	1	63	0.02
displeased	6	2	3.00	*excited*	1	424	0.00
delighted	5	31	0.16	*unwilling*	1	6	0.17
astonished	5	16	0.31	*alone*	1	31	0.03
disappointed	5	79	0.06	*diseased*	1	0	-
inclined	5	919	0.01	*well-versed*	1	0	-
				similar	1	361	-
				unsinewed	1	0	-

[a] These counts unfortunately conflate adjective and preposition uses due to tagging errors.
[b] Four of these are determiner uses of *much*, and the rest appear to be errors (e.g., **It's much hard to anticipate*).

The existence of these contrasts undermines *CGEL*'s motivation for a dual-category analysis of *more* by demonstrating that *much* and *more* are not in strictly complementary distribution. The adjectives in Table 1 appear to fall into four main groups: comparative governors, past participles, *a-* adjectives (see §3.1.3), and others.[4]

3.1.1. Comparative governors

Much–more contrasts occur with what *CGEL* (1104) calls COMPARATIVE GOVERNORS, items which license comparative complements: *different*, *superior*, *inferior*.[5] Additional comparative governor adjectives occurring in the relevant

[3] *Pretty much* has become an approximator (Bolinger 1972: 215). *Very much* may be compositional, as in *x is not very much longer than y*, but can also be non-compositional, meaning 'indeed' as in *She is very much alive* (Huddleston & Pullum 2002: 549). To control for this, the present searches were limited to *much* immediately following *be*/*seem*/*become*.

[4] See Appendix A for a cluster analysis supporting a three-way distinction.

[5] Jespersen (1956: 402) observed certain adjectives derived from Latin comparatives take "*much*, if the comparative meaning is clear, and *very*, if not", and that "*different* is felt as a kind of

contexts in COCA, though tagged as other categories, are given in (4).

(4) (a) like, different, inferior
(b) similar, unlike, preferable, akin, superior

The comparative governors in (4a) co-occur with *much*, *more*, *most*, *little*, *less*, and *least* in COCA. Those in (4b) are unattested with *little*, and there are no instances of *least akin/superior*, though all seem possible. *Little* is generally rare as an AdjP modifier. Some other comparative governor adjectives like *other*, *such* and *else* tend to resist degree modification altogether (See §5 for discussion).

3.1.2. Past-participial adjectives

Jespersen (1956: 399) observes that with past participles, "*much*, which was required on account of the verbal character," was increasingly being replaced by *very*.[6] Some of the lower-frequency items in Table 1 seem marginal to me, but all except *unsinewed*, *diseased*, and *well-versed* qualify as adjectives by *CGEL*'s criteria (Ch. 16, §10.1.3).

(5) improved, interested, concerned, anticipated, beloved, surprised, pleased, involved, indebted, amused, displeased, delighted, astonished, disappointed, delighted, inclined, preoccupied, perplexed, annoyed, worried, dismayed, dissatisfied, aggrieved, impoverished, flawed, tired, excited, unsinewed, diseased, well-versed

Other cases such as ?*much broken* and ?*much frightened* do not occur in the corpus with non-modified *much* (see fn 3) and seem less acceptable. Many of these adjectives also exhibit *little/less* contrasts (e.g., *little/less concerned*).

3.1.3. A *adjectives*

The adjectives in (6) start with *a*, resist attributive use, and are not participles. Those in (6a) contain the originally prepositional prefix *a–* meaning 'on, in, into'. Both *alike* and *alive* seem to be comparative governors in that they require two semantic arguments: the subject of *alike* must be plural or conjoined (*A and B are alike*, *we/my brothers are alike*), while *akin* explicitly licenses a PP complement. The *a* in the adjectives in (6b) is not the same prefix, but they may pattern similarly by analogy.

(6) (a) alike, akin, alive, alone
(b) afraid, aware

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comparative". Bresnan (1973) also noted the possibility of *much different*.

[6] Jespersen (1940: 423) notes, "the use of *very* with a second [i.e., past] participle is not very old," citing an example from 1760, though Annesley (1690) contains an earlier example of *very concerned*.

Expanding the search beyond the *be/seem/become* frames, there are two instances of *much averse* versus 23 of *more averse* in COCA, *averse* being another *a*–-prefixed adjective from *CGEL*'s list (559).

3.2. Less *and* least *with comparatives and superlatives*

Less rarely occurs as a pre-head modifier of comparative adjectives, but Jespersen (1956: 368) mentions *less happier*, and COCA contains 22 instances of *less worse*, 4 of *less happier*, and 3 of *less riskier*, along with a few other sporadic examples. These clearly contrast with *little worse/happier/riskier*. Similarly, *least* occurs with *worst* and other superlatives. COCA also has three instances of *less* modifying analytic comparatives: *less more likely/efficient/vulnerable*, contrasting with *little more likely/efficient/vulnerable*.

3.3. Contrasts in other phrases

Having shown in detail in §3.1 that contrasts exist in analytic comparative AdjPs, this section briefly illustrates similar patterns in other phrasal categories.

3.3.1. Contrasts in AdvPs

Contrasts in AdvPs are even rarer than in AdjPs. *Much differently* (181 instances) contrasts with the analytic comparative *more differently* (16 instances), and *would more rather* contrasts with *would much rather*. *Much too* (e.g., *much too good*) is a rare case of *much* with a plain adverb head, but curiously, **more too good* is impossible, so there is no contrast in this case. Nevertheless, it is an interesting construction which I return to in §5.1.1.

3.4. Contrasts in PPs

In preposition phrases (PPs), *CGEL* analyzes *more* and *less* as determinatives, but given the existence of synthetic comparatives in PPs like *closer to home*, it is reasonable to consider examples like (7) as involving contrasts in analytic comparatives (see §2.3).

(7) (a) Each day he was more on my mind.
(b) This is much on my mind this evening.

Many of the hits for *like* in Table 1, and perhaps *alike* as well, are actually in preposition phrases. *As* is also common in these PPs, as in (8).

(8) (a) These membranes act much as human eardrums do.
(b) I see you more as a leader of men.

3.5. *Contrasts in VPs*

Although VPs modified by *more* are not considered analytic comparatives by *CGEL*, contrasts with *much* do occur (mostly limited to negative polarity contexts), as shown in (9).

(9) (a) I didn't much enjoy the experience.
(b) I can no more understand Russian than I can fly. (constructed)

Relevant contrasts in post-head modifiers are also common, as in (10).

(10) (a) (i) It had not changed much.
(ii) It had changed more than I expected.
(b) (i) It had changed little.
(ii) It had changed less than I expected.

3.6. *Summary of contrasts*

The data presented in this section challenges *CGEL*'s claim that *more* and *much* never contrast in analytic comparatives. While such contrasts are not especially frequent, they do occur across a range of AdjPs, AdvPs, and PPs. The next section investigates whether the observed distributional differences between *more* and *much*, even if not strictly complementary, could still justify a category distinction.

4. THE VAGARIES OF MODIFICATION

In this section, I examine the differences in the distribution of modifiers within a given category across different phrase types. I conclude that, even if the contrasts identified in §3 could somehow be explained away, the distributional differences between *more* and *much* fall within the expected range of variation for determinative intensifiers and do not by themselves justify a dual-category analysis for *more*.

Intensifier distribution in adjective phrases is notoriously idiosyncratic. Bolinger (1972) devotes an entire 30-page chapter to "Some restrictions on intensifiers primarily with adjectives", yet describes it as "perhaps better than a sampling, but … far from complete." Restrictions may be dialectal (e.g., *right pleased*), register-specific (e.g., *We were little affected by what we saw*), or positional (*enough* only occurs post-head). Semantic and prosodic factors also play a role: *highly frightful* is odd because "*frightful* is already stronger than *highly* … In addition to the semantic restriction there is a tendency to avoid mono-syllabic adjectives" (Bolinger 1972: 52).

This idiosyncrasy extends to the choice between analytic and synthetic comparatives. Jespersen (1956: 359), noting that "it is not always easy to see why writers prefer one or the other method of comparing adjs," dedicates nine pages to apparently unpredictable cases of periphrasis versus inflection in AdjPs, plus two more pages on AdvPs. He observes, "the periphrastic comparatives and

superlatives with preposed *more* and *most* are found not only in those cases in which the endings *-er* and *-est* cannot be used for phonetic reasons, but also extensively in other cases" (Jespersen 1956: 382).

4.1. Determinatives as modifiers

If *more* and *less* in analytic comparatives patterned distinctly from other determinatives in AdjPs, this could potentially support an adverb analysis. But the distribution of determinative modifiers in AdjPs is quite varied, as shown in Table 2.[7]

Table 2
Determinatives as modifiers in AdjPs

CLUSTER	*more*	*less*	*enough*[a]	*that*	*much*	*no* & *any*
old		✓	✓	✓		
recent	✓	✓	✓	✓		
Comparative		✓			✓	✓
different	✓	✓	✓	✓	✓	✓
afraid	✓	✓	✓	✓	✓	
improved	✓	✓	✓	✓	✓	

[a] post-head

The *old* cluster includes *old*, *fast*, *small*, *hard*, *young*, *strong*, and *high*. The *recent* group includes *intelligent*, *dangerous*, *fortunate*, *generous*, *embarrassing*, *expensive*, and *comfortable*. The comparative group includes all words tagged as comparative adjectives (e.g., `much JJR`). The *different* group comprises *different*, *separate*, *preferable*, *superior*, *unequal*, and *inferior*. The *afraid* group includes *afraid*, *alike*, *afraid*, *alive*, *alone*, and *aware*. And the *improved* group contains *improved*, *pleased*, *delighted*, *concerned*, *beloved*, *interested*, and *surprised*.

Enough and *that* pattern similarly to *more* in their ability to modify a wide range of AdjPs, but not synthetic comparatives like *bigger*. In contrast, *much* is more restricted, while *no* and *any* are the most limited. Viewed in this broader context, the distributional data does not single out *more* as exceptional.

For AdvPs (Table 3), I've included *a little*, which patterns like *much* in modifying *too*, in place of *little* which does not occur in this context. The determinative *all* (not shown) also modifies *too*. Once again, no distributional pattern clearly identifies *more* as belonging to a distinct category.

Table 4 shows determinative modifiers in PPs. It is difficult to identify relevant preposition classes, so the items included are more opportunistic and reflect

[7] The tables in §4 reflect my judgments. See Appendix B for a corpus-based analysis.

Table 3
Determinatives as modifiers in AdvPs

EXAMPLE[a]	*more*	*less*	*enough*[b]	*that*	*much*	*a little*	*no/any*
recently	✓	✓	✓	✓			
fast		✓	✓	✓		✓	
Comparative		✓			✓	✓	✓
differently	✓	✓	✓	✓	✓	✓	✓
equally	✓	✓	✓				
too					✓	✓	

[a] Just for the words given + all tagged as JJR for Comparative
[b] Post-head

strings rather than constituents. For example, *up to* covers *up to date*, *up to the individual*, and similar cases. Still, no clear pattern emerges suggesting that *more* alone is an adverb.

Table 4
Determinatives as modifiers in PPs

EXAMPLE	*more*	*less*	*enough*[a]	*that*	*much*	*a little*	*no/any*	*all*
near		✓	✓	✓		✓		
nearer			✓		✓	✓	✓	
up to	✓	✓		✓		✓		✓
along the	✓	✓			✓	✓		✓
short of	✓	✓		✓	✓	✓		
like her	✓	✓	✓	✓	✓	✓	✓	
above the	✓	✓	✓	✓	✓	✓		✓

[a] pre- or post-head

What this highly selective comparison illustrates is considerable variation in the distribution of determinatives as modifiers. This undermines the argument for assigning *more* and *less* in analytic comparatives to a distinct category based solely on distributional facts. The differences between their behavior and that of *much* or *little* appear to fall within the expected range of variation for determinatives, potentially explainable by semantic factors.

4.2. Adverbs as modifiers

If *more* and *less* in analytic comparatives patterned similarly to adverbs in their distribution as pre-head modifiers in phrases with gradable heads, this could provide evidence for an adverb analysis. However, as shown in Table 5, *more*

exhibits a quite distinct distribution from other adverbs. In fact, there is no clear pattern; each of the eight adverbs considered has its own unique distribution.

Table 5
Selection of *more*, *less*, and adverbs as modifiers

EXAMPLE	*more*	*less*	*how*	*amazingly*	*slightly*	*much/far*	*very*
Plain Adj: *recent*	✓	✓	✓	✓	✓		✓
Plain Adj: *big*		✓	✓	✓	✓		✓
Comp Adj: *bigger*					✓	✓	
Det *much*			✓	✓			✓
Det *little*			✓	✓			✓
Det *more*				✓	✓	✓	
Det *less*				✓	✓	✓	
Det *most*							✓
Det *least*							✓

Clearly, there is no typical pattern for adverbs functioning as modifiers in these contexts. Even so, *more* appears unusually restricted in its distribution, with *less* only slightly less so. At minimum, Table 5 provides no positive evidence for *CGEL*'s claim that *more* and *less* in analytic comparatives are adverbs.

5. THE EXPLANATORY FORCE OF SCALES

Although distributional evidence may not justify categorizing *more* and *less* as adverbs, their differences from *much* and *little* still call for explanation. Building on the distributional analysis in the previous sections, this section appeals to the scale structure of adjectives (and other categories) to account for the differing distributions of *more* and *less* versus *much* and *little*.

Stevens (1946) proposed a classification system for attribute data, divided into four levels, as shown in Figure 1 (adapted from Zhang & Ling 2021: 250). These scales provide a framework for understanding the differing distributions of intensifiers and modifiers based on the scale structure of the adjectives they modify.

- NOMINAL SCALE: Categorizes data into distinct groups based on qualitative properties.
- ORDINAL SCALE: Categorizes and orders data, but does not provide information about the intervals between categories.
- INTERVAL SCALE: Categorizes, orders, and establishes equal intervals between categories, but lacks a true zero point.
- RATIO SCALE: Categorizes, orders, establishes equal intervals, and includes a true zero point.

CGEL distinguishes between gradable (≈ ordinal, e.g., *important*) and non-gradable (≈ nominal, e.g., *mutual*) adjectives, hinting at scalar constraints on

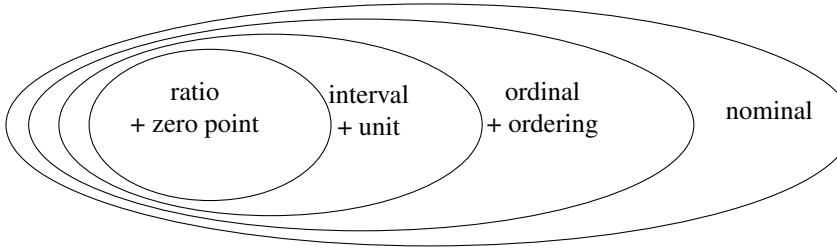

Figure 1
Venn diagram illustrating Stevens's scales hierarchy.

possible modifiers in AdjPs. But further distinctions can be made based on the other scale levels (Table 6). As more semantic scale levels are added, more constraints are imposed. For example, *one sixth as dense* is possible because density is a ratio scale, but ?*one sixth as kind* seems anomalous, presumably because kindness is not.

Table 6
Syntactic compatibility of intensifiers with plain-form adjectives of different semantic scales.

		SYNTACTIC COMPATIBILITY	
		ORDINAL	RATIO[a]
SEMANTIC SCALE	EXAMPLE ADJECTIVES	*extremely*, *slightly*, *too*, *very*, *enough*, *that*	*2.7 times as*, *one fifth as*
NOMINAL	*additional*, *equal*, *mutual*, *opposite*, *other*, *such*, *twelfth*[b]		
ORDINAL	*good*, *hard*, *important*, *interesting*, *kind*, *thirsty*	✓	
RATIO[c]	*high*, *late*, *long*, *old*	✓	✓

[a] *Half as good* or *twice as nice* are pseudo-ratio modifiers merely meaning 'much worse' or 'much better' without a genuine multiple.

[b] The ORDINAL ADJECTIVES assign an ordinal rank, but each rank has only a nominal scale (something is or is not first).

[c] The sense of these adjectives "corresponds to their interpretation when they are associated with units" (Sassoon 2007: 243), in contrast to the general sense in *He retired before he grew old*.

Scale structure can impose further constraints on possible modifiers. Scales can be open or closed at either end (Kennedy & McNally 2005). Totalizing and approximating modifiers work best with an inherent upper bound (e.g., *completely/almost straight*), but are odd with open-ended scales (e.g., ?*completely/almost bent*). Conversely, minimizing modifiers prefer a lower bound

(e.g., *slightly bent*), and are degraded without one (e.g., ?*slightly straight*). Scales can also have contextually determined reference points based on expected norms, as with *tall* meaning 'of a height noticeably greater than normal for the relevant reference group' (versus e.g. *1.7m tall*).

While the existence of the contrasts in Section 3 undermines *CGEL*'s motivation for a dual-category analysis, *more* and *much* (and *less* and *little*) do exhibit different distributions. I propose that these differences can largely be explained by their semantics and the scale structure of the expressions they modify, without positing distinct syntactic categories. Specifically, I argue that the limited distribution of *much* and *little* as modifiers follows from their requirement for a discourse-salient reference point on the relevant scale, while the broader distribution of *more*/*-er* and *less* stems from their ability to establish such a reference point. This semantic account captures the observed distributional patterns while maintaining a unified categorial treatment of these items as determinatives.

5.1. Scale-structure limitations on much *and related modifiers*

As shown in Section 4, the semantic properties of adjectives, particularly their scale structure, play a significant role in determining which modifiers they allow. For example, adjectives that inherently encode a limit or boundary on a scale, such as *straight* or *pure*, are more compatible with modifiers like *completely* or *almost* that pick out the endpoints of a scale, while adjectives that lack such boundaries, like *big* or *interesting*, are not. This is because the semantics of the modifier must be compatible with the scale structure of the modified expression.

Given this general principle, it should not be surprising that specific restrictions might apply to the modifier *much*. As a modifier in an AdjP, *much* requires the presence of a discourse-salient, scale-internal reference point for comparison (Kennedy & McNally 2005). Crucially, this reference point need not coincide with a norm or average value on the relevant scale, although it may do so coincidentally. Rather, the reference point is typically established explicitly in the discourse context, often by a comparative complement. For instance, in the AdjP *much taller than me*, the reference point is the height of the speaker, not the average height for a person. Thus, while *much* requires a reference point, it is not necessarily a norm or average, but rather a contextually salient scale value.

Establishing such a point is one function of *–er*/*more* (Zhang & Ling 2021), an idea with precedents in earlier work on the semantics of comparatives.[8] The point may be implicit, but it can typically be made explicit in a comparative complement like a *than*-PP. For instance, *It happened much more recently than yesterday* picks

[8] For example, Faller (2000: 154) notes that in von Stechow (1984)'s account, measure phrases specify the value of a "difference degree" between two compared objects, implying a scale with a lower bound. Similarly, Faller (2000: 163) discusses Bierwisch (1984)'s analysis in which comparative morphemes denote relations between individuals and "directed degrees".

out yesterday as the relevant point of reference. Once this point is established, *much* and related modifiers become possible, as shown in Figure 2. Without such a point, *much* is anomalous because the comparison size is indeterminate.[9]

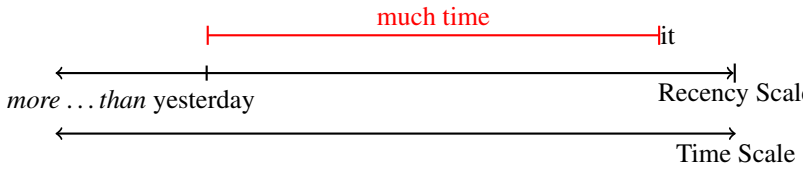

Figure 2
Illustration of the interaction between *more*/*-er*'s *than*-complement and *much* in *It happened much more recently than yesterday*.

At the same time, other modifiers are blocked, including *most*, *too*, *very*, and *extremely*. **Much most*/*–est* is likely ruled out because *most*/*–est* has a strictly ordinal semantics, while *much* – like *slightly*, *somewhat*, *significantly*, *greatly*, etc. – requires an interval semantics. *Very* and *extremely* may be incompatible because they target an absolutely high degree on the scale, without establishing the relevant reference point. In comparative constructions, it is the difference in degrees, not the absolute degree, that matters.

5.1.1. Too

Too presents an interesting case. As noted in §3.3.1, plain-form adverbs generally disallow modification by *much*, but *too* is an exception, as in *much too big*. Notably, *too* resembles *more*/*-er* in its semantics and syntax. Jespersen (1956: 391) calls it a "latent comparative", and von Stechow (1984) analyzes it as a degree operator involving universal quantification over degrees, similar to comparative morphemes. Both *too* and *more*/*-er* function primarily as modifiers in phrases headed by plain ordinal adjectives, adverbs, or prepositions; both license a complement (a *to*-infinitival for *too*); and in both cases, the complement's semantic value establishes the scale-internal, lower reference point. The key difference is that, without an overt complement, *too* sets its reference level to the maximum acceptable level based on pragmatics and social norms (Meier 2003). It is *too*'s lower reference level that allows *much* to occur in AdjPs like *It's much too big* (*to fit*), as shown in Figure 3.

[9] This approach has the nice consequence of "reducing" the modifier function of *much* to its determiner function, at least schematically. For example, *much more recently* can be conceived as having a "much time" component.

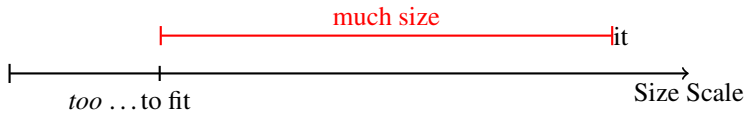

Figure 3
Illustration of the interaction between *too*'s *to*-complement and *much* in *It's much too big to fit*.

Conversely, even though *more* can often modify plain-form adverbs, **more too big* (*to fit*) (*than that*) is impossible because *more* and *too* establish competing points of comparison, making it unclear whether the comparison is with the size of another object or with the fit size.

It's worth noting, however, that the unacceptability of these constructions could potentially be explained by factors other than the semantic incompatibility proposed here. As pointed out by an anonymous reviewer, the difficulty in processing sentences like *Kim is less happier than Lee than Pat* might contribute to their perceived unacceptability. The complex structure of such sentences, with multiple embedded comparisons, poses a significant cognitive challenge. This raises the possibility that the unacceptability is due more to grammatical or processing constraints than to any fundamental cognitive limitation on combining these degree modifiers.

In sum, an adjective head's semantic scale structure significantly impacts the modifiers it allows, and these restrictions offer a compelling explanation for why *much* and *more* generally appear in different contexts. However, as shown in §3, there are contexts where both *more* and *much* may alternate. I now turn to explaining these.

5.2. Comparative governors

In §3.1.1, I showed that comparative governors like *different* allow modification by both *more* and *much*. In §5.1, following Kennedy & McNally (2005), I claimed that *much*-type modifiers require an established scale-internal reference point. And following Zhang & Ling (2021), I claimed that *more*/*-er* establish such a point. It's unsurprising that comparative governors allow *more*/*–er* modification, but it remains to be seen why they allow *much* without *more*/*–er* to establish a reference point.

I propose that, like *more*/*-er*, comparative governors allow *much* modification because their semantics establish a reference point, which may be expressed in a *than* or *from* PP complement. In (11a), the reference point is a contextually salient price made explicit in the *from*-PP.

(11) (a) This price is different (from that one).
(b) This price is more different from that one (than some other price difference).

But if that's the case, why is *more* also possible? The answer is that it establishes (implicitly or explicitly) a distinct reference point on a second-order scale – a price-difference scale. Metaphorically, *more different* is to *different* as acceleration is to speed. In (11b), the reference point is not another price, but rather the normal or expected difference between prices. In (11b), the reference point is not another price but rather the normal or expected difference between prices.

5.3. Participial adjectives

In §3.1.2, I showed that non-comparative participial adjectives like *improved*, *refreshed*, *recovered*, and *diminished* may head AdjPs in which *much* is a modifier. The explanation is the same as above: these adjectives tend to have a semantics that establishes a scale-internal reference point, which can sometimes be expressed in a PP complement, as in *It's much improved from the first draft* and the examples in (12), as illustrated in Figure 4.

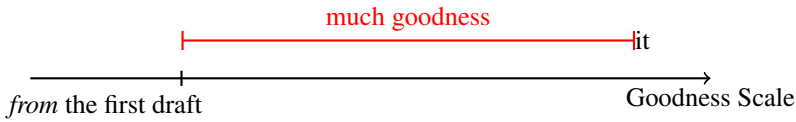

Figure 4
Illustration of the interaction between *improved*'s *from*-complement and *much* in *It's much improved from the first draft*.

In contrast, participial adjectives like *broken* lack this reference point, which disallows *much* as a modifier in (13).

(12) (a) The paper seems much improved from the first draft.
(b) She looks much recovered from her injuries.
(c) The battery life is much diminished from when it was new.

(13) (a) Her nose looked (*much) broken.
(b) He was (?much) frightened.

However, this explanation does not cover all of the possible participial adjectives. For instance *inclined* and *impressed* do not seem to establish the expected reference point. Perhaps, then, it is "on account of the verbal character" (Jespersen 1956: 399), and/or other factors.

An anonymous reviewer suggests Kennedy & McNally (2005)'s analysis of participial adjectives as a different explanation for why these words resist modification by *much*. Under this analysis, rather than lacking a reference point entirely, these adjectives may have a fixed reference point at the minimal element of their scale. For example, *broken* always refers to the state of an object just as it becomes broken, not to intermediate states of partial brokenness. This fixed

minimal reference point may be incompatible with the semantics of *much*, which requires a contextually salient reference point that can be shifted.

5.4. The a– *adjectives*

As with the participial adjectives, some of the *a–* adjectives seem to have a natural reference point (e.g., *akin* & *alike*), while others do not (e.g., *alive* & *afraid*). I don't have a good story, though, for why examples like *I was much aware* seem much better than ?*Something was much amiss*.

5.5. Other plain-form adjectives

I have found no other plain adjectives that accept simple *much* as a modifier in Modern English (e.g., **that is much true*),[10] but there are rare examples like *as much true of China* . . . . In such cases, the comparative-governor adverb *as* may license the relevant reference point. The question then becomes why this is not more broadly applicable. In fact, modified *much* (e.g., *so much*) is more flexible than *much* alone (see fn 3) for reasons that are unclear to me. A syntactically identical construction with different semantics does seem to apply more broadly, an example of which is *Sanctions are as much psychological as they are punitive*.

5.6. Problems with this account

Though the explanation accounts for much of the data, it does not account for all of it. First, as mentioned above, there are past-participial adjectives and *a–* adjectives that may head AdjPs with modifier *much*, without establishing any obvious reference point.

Second, most adjectives allow a post-head *for* PP introducing a comparison class, as in (14a), but as (14b) shows, this does not satisfy *much*'s need for a discourse-salient reference point.

(14) (a) He is short for a basketball player.
(b) * He is much short for a basketball player.

An anonymous reviewer suggests an explanation, argued for by Fara (2000) and Kennedy (2007): *for*-phrases specify comparison classes relative to which standard values are computed, but they do not determine those values directly. The actual reference points remain indeterminate, and can vary across contexts even within the same comparison class (Qing 2020). This indeterminacy may explain why *for*-phrases do not license *much* modification: they do not provide the definite reference point that *much* requires.

Third, there are two senses of adjectives such as *tall*, an ordinal one taking the standard expected tallness for the reference class as its base, as in (15a), and

[10] Middle English allows examples such as [*they*] *were moche fatte* 'they were very fat' (Jespersen 1956: 399).

a ratio one taking 0 cm as its base, as in (15b). Again, neither seems to satisfy *much*'s need for such a reference value, as illustrated by (15c).

(15) (a) He is tall.
(b) He is 2.13m tall.
(c) * He is much tall.

The same anonymous reviewer observes that it's worth noting that the distribution of measure phrases with non-comparative adjectives is highly idiosyncratic, with somewhat arbitrary variation both within and across languages (Schwarzschild 2005, Grano 2012). For example, while *tall* accepts measure phrases in English, its equivalent in some other languages may not. This idiosyncrasy poses a potential problem for the proposed analysis of *much*: if the acceptance of measure phrases is taken as a diagnostic for the presence of a reference point, then the variable acceptability of measure phrases across adjectives and languages suggests that the availability of a reference point is similarly variable.

However, a more regular pattern emerges if we focus on comparative constructions. As noted by Schwarzschild (2005) and Grano (2012), comparatives consistently accept both measure phrases and *much*-equivalents across languages. This suggests that whatever factor underlies the idiosyncratic distribution of measure phrases with non-comparative adjectives, it is distinct from the factor that licenses *much*. The consistent acceptability of *much* in comparatives, which all provide a reference point, supports the proposed analysis of *much* as requiring a definite reference point.

Nevertheless, the idiosyncratic distribution of measure phrases with non-comparative adjectives remains a puzzle.

Fourth, the story about *too* may not be the whole story. If it were, then *exceedingly* might be expected to behave similarly. On the other hand, *too* generally has a negative affective orientation to it, while *exceedingly* can have a positive affect, so perhaps their semantics simply aren't similar enough in the right ways.

5.7. Payne's counter-proposal

John Payne (personal communication, Sep 4, 2022), speculated that a difference exists between the adverb *more*, which deals with degrees, and the determinative *more*, which deals with quantities.[11] If a case had already been made for the dual categorization analysis, and I hope I have shown that it has not, then this would be an interesting observation, but it doesn't seem sufficient to motivate distinct categories.

[11] *CGEL* (393) calls these "degree determinatives".

Moreover, it doesn't hold consistently across the *CGEL* analysis. For example, (1) is clearly a degree difference, as opposed to *I dance more*, which would be a quantity difference.[12] But there is also, *not so much in control* and *Kim isn't much of an actor*, which are explicitly determinative uses of *much* (*CGEL* 395) and yet clearly require a degree interpretation (*CGEL* 415). Furthermore, as Payne acknowledges, it isn't the case that determinatives in general do not deal with degrees. For instance, "*that* seems to be more flexible. As a demonstrative, it can point either to a particular degree for a degree concept or a particular amount for a quantity concept" (personal communication, Sep 4, 2022). Nor does this proposal clear up any of the difficulties with the explanation advanced in §5.6.

Payne has also suggested (personal communication, Oct 30, 2023) that perhaps there are two *much* items, one being an NPI, and the other not. Indeed, in the modifier cases discussed in §3, *much* shows little polarity sensitivity, while elsewhere *much* is polarity sensitive. But Israel (2011: 41) has observed that "even the most robustly polarity sensitive forms tend to have usages which belie their status as polarity items." In fact, the overwhelming majority of examples in the *OED* before 1950 show no polarity sensitivity, while only about half since do. Given the above, it wouldn't do to base a category distinction on polarity sensitivity, nor does such a move have any precedence in *CGEL*.

5.8. Summary of the explanatory force of scales

Overall, then, scales and the scale structures of individual adjectives have a significant impact over the selection of modifiers allowed by various heads in AdjPs. In other words, semantic and pragmatic factors play a huge role in (dis)allowing modifiers. This extends to most of the observed difference in distribution between *much* and *many* as modifiers in AdjPs. This does not preclude a categorial difference between *much* and *more* (and by extension *little* and *less*), but it certainly undermines the motivation for it.

6. The Complementarity Argument

In arguing that adverbs are a distinct category from adjectives, Payne et al. (2010: 61) conclude that,

> clearly, in these cases where the same forms are complementary in some environments and contrastive in others, it is not the distribution *per se* which leads us to think of a derivational relation between *wood* and *wooden*, and an inflectional relation between [the Russian nouns] *soldat* and *soldatom*. And even if, as a thought experiment, *wood* and *wooden* on the one hand and *soldat* and *soldatom* on the other always stood in complementary distribution, would this alter our decision? We think not: it seems that factors other than simple distribution are the crucial ones.

[12] "In clause structure [*more* and *less*] are forms of the determinatives *much* and *little* rather than adverbs" (*CGEL* 585, n17).

Although this quote pertains to the entire lexical category of adverbs, the principle should apply equally to individual words. The question of whether the relations between *much* and *more* and between *little* and *less* should be considered inflectional in all cases or only sometimes should not hinge on whether or not they stand in complementary distribution. And yet, the fundamental assumption underlying the categorization of *more* as an adverb relies on precisely this reasoning. Table 7 demonstrates the lack of a consistent relationship between distributional contrast and category assignment in *CGEL*'s analyses.

Table 7
Distribution and category contrast

	CONTRASTING	NON-CONTRASTING
SINGLE CATEGORY	*much*$_{\text{D}}$ *more*$_{\text{D}}$	*mere*$_{\text{ADJ}}$ *elect*$_{\text{ADJ}}$
DUAL CATEGORIES	*you*$_{\text{D}}$ *your*$_{\text{PRON}}$	*mere*$_{\text{ADJ}}$ *merely*$_{\text{ADV}}$

6.1. Little *and* less*?*

The arguments in this paper have focused primarily on the *much*/*more* distinction, but they apply equally to *little* and *less*. This contrasts with *CGEL*'s original claim about the lack of contrast. While AdjPs like *less worse* and *less happier* are not common, an example like (16) seems perfectly acceptable to me. In this case, there was a deal which was worse than the current situation, and now there's a third deal which is still worse, but slightly less so.

(16) It could finally settle on a slightly less worse deal with the unions.

If only half of the analytic comparative pair (*more*/*less*) truly lacked contrast – and to be clear, I argue that neither lacks contrast – then in which direction should a complementarity argument pull, assuming such arguments had any force to begin with? It's not at all clear that it would necessarily group *less* with *more* into a different category from *much* and *little*.

6.2. Categorization options

Even if all the evidence and arguments presented here were set aside and it could be shown conclusively that *more* and *much* belonged to different categories, the question of which specific categories they belong to would still need to be addressed. While determinative and adverb are plausible options, *CGEL* offers no principled reason for assigning *more* to the adverb category as opposed to *much*. The choice seems arbitrary.

7. CONCLUSION

In this paper, I have argued that the words *more* and *less* are determinatives in all contexts, contrary to their categorization in *CGEL*. I have shown that *CGEL*'s

conception of analytic comparatives overlooks PPs such as *closer to home* and *more like home*. Because *CGEL* analyzes *more* as a determinative in these cases, its analysis is internally inconsistent. I have demonstrated that contrasts between *more* and *much* exist in various contexts, including with comparative governors (e.g., *more*/*much different*) and certain participial adjectives (e.g., *more*/*much improved*), contradicting *CGEL*'s claim that *more* and *much* never contrast in analytic comparatives. Although I have focused on *more* and *much*, the arguments extend to *most*, *less*, *little*, and *least*.

I have proposed an explanation for the distributional patterns in AdjPs based on the pragmasemantics of *more*/*-er* and *much*. Specifically, *more*/*-er* establishes a salient minimum value in the discourse where none might otherwise exist, while *much* requires such a value. This explains not only why *much* tends to be limited to comparative contexts, but also why it appears with comparative governors, certain participial adjectives, and *too*. It also explains why *more* and *too* cannot modify each other. However, some puzzles remain, such as the variable applicability of *much* among the *a–* adjectives.

Finally, I have argued that *CGEL*'s reliance on the lack of contrast is theoretically unsound.

I conclude that *more* and *less* are most parsimoniously categorized as determinatives, and that their categorization as adverbs is not justified in any context.

Beyond the specifics of *more* and *less*, this study highlights the importance of empirical evidence in grammatical analysis. By rigorously examining corpus data, we can test existing grammatical descriptions and propose refinements where necessary. Even widely accepted analyses should be subject to ongoing scrutiny and revision in light of new evidence, as Geoff Pullum has demonstrated throughout his career.

Moreover, the categorization of *more* and *less* serves as a case study in the contribution of various linguistic sub-fields to the resolution of grammatical categorization. While traditional approaches have often prioritized distributional criteria for category assignment, this study suggests that semantic and pragmatic factors can also play a crucial role. The fact that the distribution of *more* and *less* can be largely explained by their meaning and pragmatic context raises questions about the primacy of syntactic criteria. More broadly, it suggests that a comprehensive understanding of linguistic categories requires an approach that integrates insights from multiple aspects of linguistic analysis.

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A. Statistical analysis of adjectives in COCA

In the main body of the paper (§3.1), I discussed the patterns of adjectives that head AdjPs modified by *much* based on the Corpus of Contemporary American English (COCA). This appendix provides a more detailed statistical analysis of these adjectives, along with a visual representation, to support the arguments made in the paper.

Principal component analysis (PCA) was performed on the pointwise mutual information scores of the adjectives as modified by the determinatives (e.g., *much bigger*, details follow) to reduce the dimensionality of the data. The elbow method determined that three clusters were optimal. Then the *k*-means clustering algorithm was then applied, with the resulting clusters shown in Figure 5. The first two principal components (PC1 and PC2) are used to visualize the data in two dimensions. The R code (R Core Team 2023) used to generate the figure is as follows:

```
# Configuration information
# R version 4.3.1 (2023-06-16) -- "Beagle Scouts"
# ggplot2 version 3.4.4
# ggrepel version 0.9.4
# os: MacOS Sonoma 14.0
# Platform: aarch64-apple-darwin20 (64-bit)

# Install and load required packages
install.packages(c("ggplot2", "ggrepel"))
library(ggplot2)
library(ggrepel)

# Load the data
data <- read.csv("adjnpmi.csv", row.names = 1)

# Keep only numeric columns
data_numeric <- data[sapply(data, is.numeric)]

# Scale the numeric data
data_scaled <- scale(data_numeric)

# Perform k-means clustering with 3 clusters
set.seed(123)
km_result <- kmeans(data_scaled, centers=3)

# Add cluster assignments to the data
data$cluster <- as.factor(km_result$cluster)

# Perform PCA for visualization
```

```
pca_result <- prcomp(data_scaled)
pca_data <- as.data.frame(pca_result$x[,1:2])
colnames(pca_data) <- c("PC1", "PC2")
pca_data$cluster <- data$cluster
pca_data$label <- row.names(data)

# Plot the data
ggplot(pca_data, aes(x=PC1, y=PC2, color=cluster)) +
  geom_point() +
  geom_label_repel(aes(label=label),
                   box.padding = 1,
                   point.padding = 1,
                   segment.color = 'grey50',
                   max.overlaps = 1000) +
  theme(axis.title=element_blank(),
        axis.text=element_blank(),
        axis.ticks=element_blank())
```

The PCA visualization (Figure 5) shows that comparatives (in blue) form a tight cluster, indicating shared linguistic characteristics, with *different* as an outlier. The red cluster includes the most typical adjectives that participate in synthetic and analytic comparatives. *Expensive*, though in the green cluster, could fit into the red one. *Separate*, in the red cluster, was included as a quasi-comparative governor (governing a *from* PP). The green cluster contains the other comparative governors (except *different*), the *a–* adjectives, and the past participial adjectives, which are kept distinct in the paper to explain their compatibility with both *much* and *more*.

Overall, the clustering aligns well with the observations in the main text, reinforcing the distinctions between adjective types in terms of determinative modification. This supports the paper's main arguments about the distributions of *much* and *more*.

The adjnpmi.csv file is available from https://XXXXXX, along with the excel file from which it is derived. The csv includes normalized pointwise mutual information scores (NPMI, ranging from −1 for no occurrences to +1 for $N - 1$ occurrences; see Equation 1; Bouma 2009) for adjectives modified by determinatives from the set {*more*, *less*, *enough*, *that*, *little*, *much*, *no*, *any*}in two contexts: Mod + Head + punctuation and Mod + Head + preposition (*enough* only post-modified). The"DQ" (disqualified) column counts the number of irrelevant or false positive examples that were manually identified and removed from the analysis. For modifier-head pairs with over 100 hits, a random sample of 100 was checked, and the proportion of disqualified examples was extrapolated to the full count. After this manual verification process, I'm confident the NPMI scores in the csv file are not distorted by false positives, though some false negatives may exist.

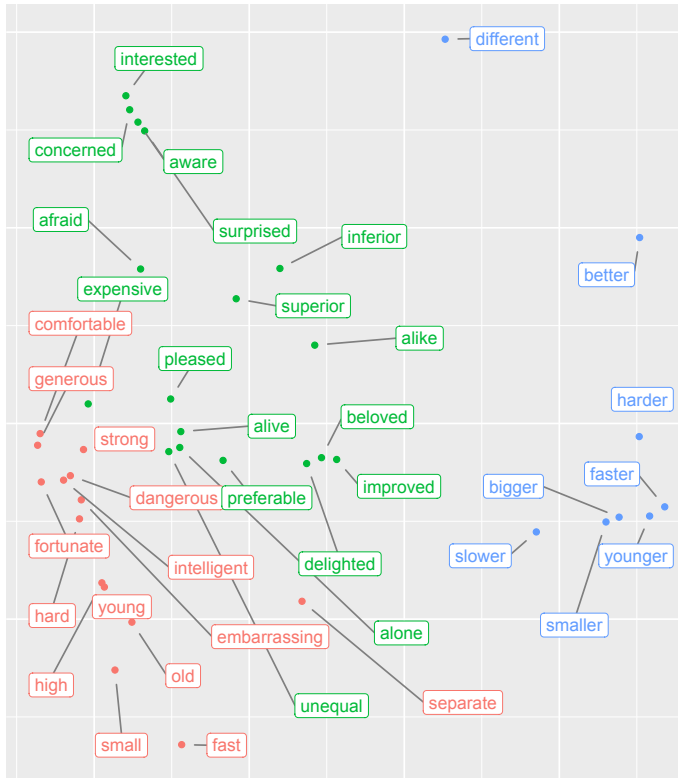

Figure 5
Visualization of adjective types based on pointwise mutual information scores. Points represent individual adjectives positioned by principal component analysis. Colours differentiate three *k*-means clusters: **red**: basic adjectives + *separate*, **blue**: comparatives + the outlier *different*, and **green**: other adjective forms (the comparative governors, the *a*– adjectives, and the past-participial adjectives) + *expensive*.

$$\mathrm{NPMI}(x;y) = \frac{\log_2\left(\frac{n_{xy}}{N} \times \frac{N}{n_x \times n_y}\right)}{-\log_2\left(\frac{n_{xy}}{N}\right)} \tag{1}$$

Here, N is the COCA size: 1,002,889,754 words (personal communication, Mark Davies, Oct 21, 2023).

B. NPMI SCORES FOR MODIFIER–HEAD PAIRS

This section examines specific adjective, adverb, determinative, and preposition heads, showing their pairings with different modifiers. NPMI scores from COCA assess the grammaticality of these pairings, empirically evaluating the judgments

in Tables 2–5. The results are visualized as heatmaps.

While there is no universally accepted statistical measure of grammaticality, NPMI serves as a reasonable proxy when investigating modifier constraints in AdjPs. For instance, *much* strongly correlates with comparative adjectives, yielding an NPMI of 0.38, whereas the ungrammatical **any old* has no relevant instances, resulting in an NPMI of -1.[13]

Figure 6 was produced using the following R script, with minor variations for subsequent figures:

```
    # Load necessary libraries
library(ggplot2)
library(reshape2)

# Load data
data <- read.csv('/path/to/your/d-adj-table.csv')

# Melt data for ggplot2 using the corrected column
    name
data_melted <- melt(data, id.vars = "Adjective.group")

# Set the factor levels for "Adjective.group" to
    retain the original order
# Reverse the order so that it matches the original
    table
data_melted$Adjective.group <- factor(data_melted$
    Adjective.group, levels = rev(unique(data$
    Adjective.group)))

# Define colors for heatmap
midpoint <- (-1 + 0.28) / 2
color_scale <- scale_fill_gradient2(low = "#F26161",
    mid = "white", high = "#5DB56E",
                                    midpoint =
                                        midpoint,
                                        limits = c(-1,
                                         0.28))

# Plot heatmap
ggplot(data_melted, aes(x = variable, y = `Adjective.
    group`, fill = value)) +
  geom_tile() +
```

[13] To provide a bit more calibration, in COCA, *Puerto Rico* has an NPMI of 0.93, *vice president* is 0.71, and *good morning* is 0.46.

```
color_scale +
theme_minimal() +
labs(x = "Modifier", y = "Head")
```

B.1. Determinative Modifiers + adjective Heads

Figure 6 displays NPMI scores for determinative modifiers and adjective heads, grouped as in Figure 5. The *old* group contains basic adjectives; the *recent* group includes other plain adjectives; comparative adjectives are grouped together; the *different* group has comparative governors; the *afraid* and *improved* groups contain *a–* and participial adjectives, respectively.

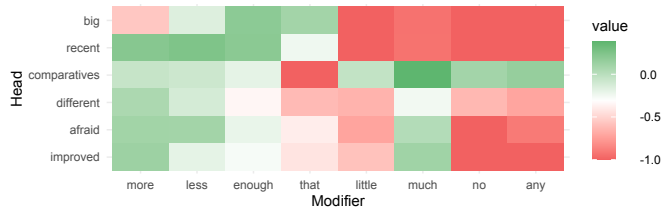

Figure 6
Heatmap of Normalized Pointwise Mutual Information (NPMI) scores between adjective Heads and determinative Modifiers in COCA. Scores range from -1 (red) to 0.38 (green), with neutral associations centered in white.

B.2. Determinative modifiers + adverb heads

Figure 7 shows NPMI scores for determinative modifiers with individual adverb heads.

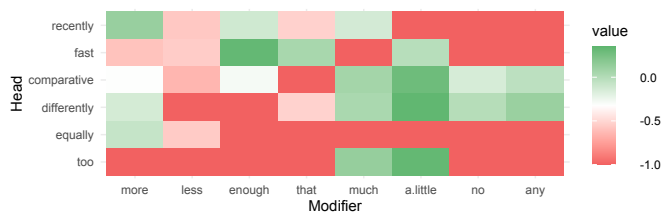

Figure 7
Heatmap of Normalized Pointwise Mutual Information (NPMI) scores between adverb Heads and determinative Modifiers in COCA. Scores range from -1 (red) to 0.34 (green), with neutral associations centered in white.

B.3. Determinative modifiers + preposition heads

Figure 9 displays NPMI scores for determinative modifiers with preposition heads.

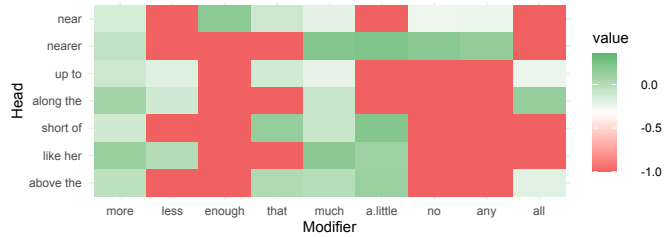

Figure 8
Heatmap of Normalized Pointwise Mutual Information (NPMI) scores between preposition Heads and determinative Modifiers in COCA. Scores range from -1 (red) to 0.22 (green), with neutral associations centered in white.

B.4. Adverb modifiers + various heads

Finally, Figure **??** presents NPMI scores for adverb modifiers with various heads.

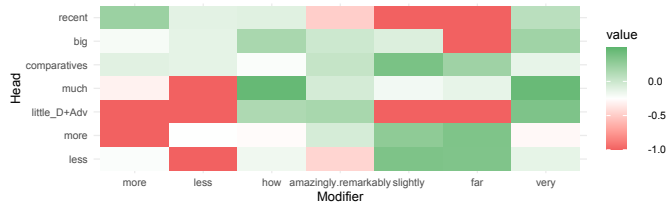

Figure 9
Heatmap of Normalized Pointwise Mutual Information (NPMI) scores between various Heads and adverb Modifiers in COCA. Scores range from -1 (red) to 0.46 (green), with neutral associations centered in white.

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