

A Semantic Universal for Modality*

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Abstract This paper articulates a new semantic universal for modal expressions in natural language, dubbed the Independence of Force and Flavor (IFF). This property accommodates counterexamples to [Nauze 2008](#)'s proposed universal from variable-force variable-flavor modals ([Bochnak 2015a,b](#)) and attitude verbs ([Močnik & Abramovitz 2019](#)), while still ruling out unattested modals. It may also be seen as a form of convexity applied to modals.

Keywords: modals, typology, variable force, variable flavor, semantic universals

1 Introduction

Theoretical linguistics has been centrally concerned with explaining the restricted variations of the languages of the world: while languages vary greatly in their surface properties, they do not do so arbitrarily/unrestrictedly. This can be phrased in terms of the search for *linguistic universals*: properties shared by all (or nearly all) languages ([Greenberg 1966](#), [Comrie 1989](#), [van der Hulst 2008](#)).¹ Although much early work on universals focused on phonology, morphology, and syntax, since at least [Barwise & Cooper 1981](#), the search for and explanation of *semantic universals* has blossomed. See [von Stechow & Matthewson 2008](#) for an overview.²

The present paper articulates a new semantic universal for *modality* ([Kratzer 1981, 1991, Matthewson 2019](#)), in response to counterexamples to a previously

* [Acknowledgments to be added in the future.]

1 This formulation is intended to include both implicational universals (since the relevant implications can be seen as complex properties of a language) and merely robust statistical tendencies (via the 'nearly all' qualifier; [Evans & Levinson 2009](#)).

2 We note that this review, in 2008, focuses on the statement of universals, noting that "we do not think that at this point, we have sufficient material to even consider possible functional explanations for given semantic universals" (p. 148). Since then, a considerable amount of work has offered such explanations, a point to which we return in the conclusion.

proposed one (Nauze 2008). Much semantic theorizing about modals has focused on two axes on which they vary: *force* (quantificational strength) and *flavor* (the type of possibilities being quantified over). Cross-linguistic research has found considerable variation in how these two axes are specified: many languages (e.g. English, German) have modals that specify force but not flavor; yet others (e.g. St’á’timcets (Rullmann, Matthewson & Davis 2008), Nez Perce (Deal 2011)) have modals that specify flavor but not force; yet others have modals which specify *both* (e.g. Paciran Javanese (Vander Klok 2013a)); and yet others have modals that specify neither (e.g. Washo (Bochnak 2015a,b), Koryak (Močnik & Abramovitz 2019)).

Amidst this considerable variation in how modals express force and flavor, the new universal—the Independence of Force and Flavor (IFF)—states that these two axes of variation in modal semantics are in fact *independent* of each other, in a sense to be made precise. This universal captures the guiding idea in modal semantics in a relatively theory-neutral way while (i) accomodating all currently known modals, including counterexamples to a previously proposed semantic universal (Nauze 2008) and (ii) ruling out possible but unattested meanings.

The paper is structured as follows. We first (Section 2) introduce the basic ingredients of modal force and flavor and our framework for formulating universals in a relatively theory-neutral manner. With that in place, Section 3 introduces Nauze 2008’s semantic universal (which we dub the Single Axis of Variability (SAV) Universal) and the recently discovered counterexamples thereto. We then (Section 4) introduce the IFF Universal and show how it makes sound typological predictions, including accommodating the aforementioned counterexamples, before concluding (Section 5) with directions for future work.

2 Modal Semantics and Framework

Modals are expressions that are used to talk about alternative ways the world could be, over and above the way the world actually is. Paradigms are the English auxiliaries *may* and *must*. Since at least Kratzer 1981, the semantics of modals have been explicated in terms of two axes of variation: force and flavor. These axes can be illustrated with the following examples.

- (1) a. [Context: a friend walks in and shakes off a wet umbrella. You say:]
It *must* be raining.
- b. [Context: you are reading the specifications of a homework assignment.
It partially reads:]
You *must* upload your homework as a PDF.

- (2) a. [Context: a friend is leaving and grabs an umbrella on the way out, saying:]
It *may* be raining.
b. [Context: a mother offers a treat to a child for finishing an assignment:]
You *may* have a cookie.

The *must* examples exhibit strong (i.e. universal) force, but differ in flavor. For example, (1a) can be glossed as saying: all of the worlds compatible with my evidence are worlds in which it is raining. The universal quantification represents the force, and the domain of worlds (those compatible with my evidence) the flavor, in this case epistemic. (1b) exhibits universal force with deontic flavor, roughly saying that all the worlds in which you follow the rules are ones in which you upload a PDF. The examples with *may* in (2) exhibit weak (i.e. possibility) force: their meaning says that some world satisfies the prejacent. (2a) and (2b) again differ in flavor, with the former being epistemic and the latter being deontic.

In addition to epistemic and deontic flavors, many others have been identified: bouletic (worlds in which desire are fulfilled), teleological (worlds in which goals are satisfied), et cetera. Similarly, there are arguably more forces than just weak and strong: for instance, there are weak necessity modals (e.g. *should*, *ought*) which intuitively express universal quantification over a smaller domain of worlds (von Stechow & Iatridou 2008). See Matthewson 2019 and references therein for further discussion of these two axes.

The examples above show that English modals lexically specify modal force (each modal has a fixed quantificational force) but exhibit variability across flavors (the modals can express more than one flavor). We note that such variability does not require that all modals in English can express all flavors: for instance, *might* arguably can only be used epistemically. Kratzerian semantics for modals capture this by hard-coding quantificational force into the meaning of a modal but relying on context to determine the flavor.³

Not all languages are like English: some exhibit so-called *variable force modals*, which specify flavor but not force. This has been found at least in St'át'icmets (Rullmann, Matthewson & Davis 2008), Nez Perce (Deal 2011), Old English (Yanovich 2016), and Pintupi-Luritja (Gray 2021).⁴ We illustrate the phenomenon with elicited examples of St'át'icmets *k'a*:⁵

³ Typical implementations determine the flavor as the product of two parameters: a modal base and an ordering source. We set aside this distinction for present purposes and focus only on flavor.

⁴ We will discuss modals that specify neither force nor flavor in the next section.

⁵ These are examples (5c) and (5e) from Rullmann, Matthewson & Davis 2008, p. 321. See their footnote 5 on p. 320 for the abbreviations.

- (3) a. [Context: You have a headache that won't go away, so you go to the doctor. All the tests show negative. There is nothing wrong, so it must just be tension.]
 nilh *k'a* lh(e)l-(t)-en-s-wá(7)-(a) ptinus-em-sút
 FOC INFER from-DET-1SG.POSS-NOM-IMPf-DET think-MID-OOc
 'It *must* be from my worrying.'
- b. [Context: His car isn't there.]
 plan *k'a* qwatsáts
 already INFER leave
 'Maybe he's already gone.'

(3a) shows *k'a* being used with strong force and epistemic flavor. (3b) shows *k'a* being used with weak force and epistemic flavor. Further analysis in Rullmann, Matthewson & Davis 2008 shows that *k'a* can only be used with epistemic flavor, so it is an example with lexically specified flavor but variable force.

In order to state universals for modals in a relatively theory-neutral manner (i.e. in a way that does not presuppose a particular formal semantic implementation), we make the following assumptions. We assume that force and flavor are fundamentally properties of contexts of use. This reflects current practice in semantic fieldwork as applied to modality (Matthewson 2004, Bochnak & Matthewson 2020, Vander Klok 2021).⁶ For example, the modal questionnaire of Vander Klok 2021 consists exactly of discourse contexts designed to isolate a single force-flavor pair. These contexts can be used at least for elicitation, translation, and acceptability tasks. Finally, we will say that a modal *M* can express a force-flavor pair just in case a bare positive sentence of the form *Mp* is judged felicitous in a context with that pair.⁷

At this level of generality, we will represent the meaning of a modal as being a set of force-flavor pairs. The semantic universals that we will discuss will be constraints on what kinds of meanings (sets of such pairs) are attested in the languages of the world. For notation, for a modal *m*, let $\llbracket m \rrbracket$ be the set of force-flavor pairs it can express. Furthermore, we will write $\text{fo}(m) = \{\text{fo} \mid \exists \text{fl s.t. } (\text{fo}, \text{fl}) \in \llbracket m \rrbracket\}$ and *mutatis mutandis* for $\text{fl}(m)$.

We adopt this level of generality because it avoids commitment on the exact formal semantics of these expressions, which is often still being debated. For example, we can say that a *variable force modal* is one that can express more than

⁶ In addition to the particular studies already mentioned, see Matthewson 2013, Cable 2017 for more examples of the application of these methods.

⁷ We intend 'judged felicitous' to also include the case where such sentences are produced naturally in elicitation tasks, as well as when such sentences are found in naturally-occurring contexts which have a clear force-flavor pair.

one pair with the same force. This is useful because there are two broad approaches to the semantics of such variable force modals: they actually encode existential quantification but lack a universal scalemate (Deal 2011) or they encode universal quantification but rely on some mechanism of domain restriction (Rullmann, Matthewson & Davis 2008, Bochnak 2015a, Močnik & Abramovitz 2019). On such analyses, the underlying semantics contains one specific quantifier; in the present setting, they will still be considered variable force since bare positive sentences are used in contexts with multiple forces.

3 Nauze's Universal and Counterexamples

While the previous section has shown that some modals exhibit variability on the flavor axis (e.g. English *may*) and some modals exhibit variability on the force axis (e.g. St'át'imcets *k'a*), all of the previously discussed expressions are not variable on the other axis. This pattern was observed across many languages from many different families. As a result of a detailed study of the modal systems of six typologically unrelated languages, Nauze 2008 proposed a semantic universal stating that modals cross-linguistically can in fact only exhibit variation along a single axis:

THE SINGLE AXIS OF VARIABILITY (SAV) UNIVERSAL: All modals in natural language satisfy the single axis of variability property: if a modal can express more than one flavor, it can only express one force (and *mutatis mutandis* for force and flavor). That is to say: a modal may exhibit variable force or variable flavor, but not both.⁸

[Alternative formulation: $|\text{fo}(m)| = 1$ or $|\text{fl}(m)| = 1$, where $|\cdot|$ is the set cardinality function.]

At least two counterexamples to this universal have been discovered. The first comes from Washo. Bochnak 2015b,a has argued that the modal verb *-e?* can be used in both possibility and necessity contexts with a range of modal flavors. In other words, it exhibits variation both on the force axis as well as the flavor axis. Similarly, Močnik & Abramovitz 2019 demonstrate that the Koryak attitude verb *ivək* can be used to express both necessity and possibility. For the doxastic flavor, this means that *ivək* can be used to mean roughly 'believe' (necessity) as well as 'allow for the possibility that' (possibility). They also argue that the expression can be used to express both doxastic and assertive flavors, thus demonstrating variability on both

⁸ Here is the formulation in Nauze 2008, p. 222: "Modal elements can only have more than one meaning along a unique axis of the semantic space: they either vary on the horizontal axis and thus are polyfunctional in the original sense of expressing different types of modality or they vary on the vertical axis and can express possibility and necessity, but they cannot vary on both axes."

axes.⁹ Bochnak and Močnik & Abramovitz use different variants of the universal quantifier plus choice function analysis of Rullmann, Matthewson & Davis 2008 to analyze the respective expressions.

We note also that a refinement of Nauze’s SAV due to Vander Klok 2013b (as reported and discussed in Matthewson 2019) does not accommodate these counterexamples. In particular, Vander Klok proposes that *a modal system as a whole* may only exhibit variability on a single axis in each of the root and epistemic domains. That is: if one root modal exhibits variability on the flavor axis, no other root modal exhibits variability on the force axis (though an epistemic modal may do so) and *mutatis mutandis* for epistemic modals and also for the force axis. This proposal is strictly stronger than Nauze’s: if a language satisfies Vander Klok’s generalization, then every modal therein satisfies SAV. For this reason, counterexamples to the SAV are also counterexamples to this proposal.

4 The Independence of Force and Flavor (IFF) Universal

The counterexamples to the SAV universal show that some languages have modals which are contextually underspecified for *both* force and flavor. It does not follow from this, however, that arbitrary sets of force-flavor pairs are expressed. Intuitively, one does not expect to find a modal in a language that can only express, for instance, epistemic necessity and teleological possibility. We can use this intuition to define a new semantic universal for modals.

THE INDEPENDENCE OF FORCE AND FLAVOR (IFF) UNIVERSAL: All modals in natural language satisfy the independence of force and flavor property: if a modal can express the pairs (fo_1, fl_1) and (fo_2, fl_2) , then it can also express (fo_1, fl_2) and (fo_2, fl_1) .

[Alternative formulation: a modal m satisfies the IFF property just in case $\llbracket m \rrbracket = fo(m) \times fl(m)$, where \times is the Cartesian product.]

This universal captures the guiding idea from Kratzer 1981 and much subsequent theorizing on the semantics of modals that force and flavor are *independent* axes of meaning. In the standard semantics, this is captured by the separation of quantification from the modal base and ordering source which jointly specify the domain of that quantifier and thereby the flavor. The IFF Universal expresses this conception of independence in a theory-neutral way and proposes it as a substantive universal

⁹ There are also apparently bouletic uses of *ivək*, but Močnik & Abramovitz 2019 argues that this flavor does not come from *ivək* alone but from interaction with material in the embedded clause.

on the semantics of modals cross-linguistically.¹⁰ We now note that it makes sound typological predictions and can be seen as a form of *convexity*.

4.1 Typological Predictions

Both of the known counterexamples to the SAV Universal appear to satisfy the IFF Universal. [Bochnak 2015a](#) reports felicitous uses of Washo *-eʔ* in weak and strong contexts for both epistemic, deontic, and future flavors. Note that the paper does present bouletic necessity and weak necessity uses, without a bouletic possibility use and with no other weak necessity cases. There are a few things to note here. One, Bochnak does not report that *-eʔ* cannot be used in bouletic possibility contexts. Two, it is not reported whether *-eʔ* can or cannot express weak necessity with other flavors. Further work may be done to test whether *-eʔ* can be used in all of those contexts. Three, the final semantic analyses given in both [Bochnak 2015a](#) and [Bochnak 2015b](#) do satisfy the IFF Universal. Taken together, the evidence suggests that *-eʔ* does satisfy IFF.

Similarly, [Močnik & Abramovitz 2019](#) report that Koryak *ivək* can be used to express both doxastic and assertive flavors with both strong and weak force. Because it can be used to express all four combinations of these two flavors and forces, it satisfies IFF.

The IFF Universal still places substantive constraints on modal semantics, ruling out unattested meanings. Consider a hypothetical modal *mighst* which behaves like a mix of English *might* in that it can be used in epistemic possibility contexts and a dimension of *must* in that it can be used in deontic necessity contexts. But this hypothetical *mighst* can only be used in those two types of contexts. This expression does not satisfy the IFF Universal, since it cannot be used in epistemic necessity or deontic possibility contexts. Accordingly, we do not expect to find such a modal in any of the languages of the world.

While many modals do exhibit variability in one or both of the axes of force and flavor, modals that directly specify *both* force and flavor also satisfy the IFF Universal. As an example, [Vander Klok 2013a](#) shows that Paciran Javanese has an expression *mesthi* that can only be used in epistemic necessity contexts, another *oleh* that can only be used in deontic possibility contexts, and another *iso* that can only be used in circumstantial possibility contexts. In terms of the framework introduced above, $\llbracket m \rrbracket$ is a singleton for each of these modals. Expressions that express singleton

¹⁰ One sense in which the formulation can be seen as ‘theory-natural’: [Kratzer 1981](#) builds in independence by treating force as lexically encoded and flavor as contextually determined. The present level of analysis does not commit to any positive view on which components are lexically specified and which are not. Thanks to Wataru Uegaki (p.c.) for discussion here.

sets satisfy IFF (‘trivially’, in a sense): because there is only one force-flavor pair, every ‘combination’ of possible force and flavor is also expressed.

4.2 Convexity and Alternative Formulations

In addition to getting the typological facts right, a more general motivation for the IFF Universal arises from the fact that it can be seen as an application of the concept of *convexity* to the modal domain. In general, a (geometric) space is convex just in case for every two points contained therein, the line connecting them lies entirely within the space as well. (This has the effect of forcing ‘smooth borders’ on the space; regular polygons are paradigmatic convex spaces.) Gärdenfors 2000, 2014 has argued that natural language meanings (especially in the content domain) denote convex regions of semantic spaces. This has been developed most thoroughly for color terms (Jäger 2010, Steinert-Threlkeld & Szymanik 2020). Chemla, Buccola & Dautriche 2019 has recently extended the idea to a domain of function words, showing that monotonicity of quantifiers can be seen through the lens of convexity (which they call connectedness).

The IFF Universal can be seen as a form of convexity when applied to sets of force-flavor pairs. Following Chemla, Buccola & Dautriche 2019, we can formulate convexity very generally in terms of a concept of ‘betweenness’: a set S is convex just in case for any a, b, c , if $a, c \in S$ and b is in between a and c , then b is in S . To apply this in the present framework, we need a definition of betweenness that applies to force-flavor pairs:

- (4) (fo_b, fl_b) is in between (fo_a, fl_a) and (fo_c, fl_c) just in case: $(fo_b = fo_a$ or $fo_b = fo_c)$ and $(fl_b = fl_a$ or $fl_b = fl_c)$.

We note that this definition captures the following intuitive sense of betweenness. One may view force-flavor pairs as lying on a two-dimensional grid, with one axis for force and one for flavor (see Table 1 below). Given two such pairs (fo_a, fl_a) and (fo_b, fl_b) , one can transform the former into the latter (i.e. move from one to the other) by first changing fo_a to fo_b and then fl_a to fl_b , or by first changing the flavor and then the force.¹¹ The pairs that will be generated in this transformation process are exactly those that lie in between the two pairs according to this definition.

With this definition of betweenness in hand, we can show that IFF is equivalent to convexity. Recalling that a modal m satisfies IFF just in case $\llbracket m \rrbracket$ has the IFF property:

- (5) $\llbracket m \rrbracket$ has the IFF property just in case $\llbracket m \rrbracket$ is convex.

¹¹ While this intuition is given in terms of ‘changing’, it also applies to the case where $fo_a = fo_b$ and/or $fl_a = fl_b$.

This follows from the following observation: the pairs (fo_1, fl_2) and (fo_2, fl_1) mentioned in the formulation of IFF are exactly the force-flavor pairs that lie in between (fo_1, fl_1) and (fo_2, fl_2) .

With these concepts in hand, we note that a property *weaker* than convexity appears to be consistent with the presently known typological facts.¹² In particular, IFF/convexity requires that *all* points lying between two force-flavor pairs in $\llbracket m \rrbracket$ are also in $\llbracket m \rrbracket$. One could instead define a notion of PATH CONNECTEDNESS by replacing this universal quantification with an existential (equivalently: replacing the ‘and’ with an ‘or’ in the statement of IFF above): if (fo_1, fl_1) and (fo_2, fl_2) are in $\llbracket m \rrbracket$, then *some* force-flavor pair in between them is also in $\llbracket m \rrbracket$.¹³ This property makes the same predictions as IFF on the data discussed in Section 4.1: the two counter-examples to SAV satisfy it, and the hypothetical *mighst* does not.

There are two *prima facie* reasons to prefer IFF (convexity) over path-connectedness. First: strength is a virtue. *Ceteris paribus*, a stronger universal rules out more hypothetical modals. Insofar as it makes sound typological predictions, then, the stronger one is to be preferred. Second: the connection to convexity provides indirect theoretical support for IFF. Insofar as convexity appears to be a factor shaping semantic typology in a wide range of domains across both the content and functional parts of the lexicon, it is a virtue that IFF can be seen as implementing convexity for modals.

That being said, should counterexamples to IFF be discovered, path-connectedness represents a natural candidate for a weaker semantic universal for modality. Table 1 (column (b)) shows what a modal that satisfies path-connectedness but not IFF would look like. At present, such a modal has not been attested, but future descriptive work could uncover such a modal.

	epi	deon	teleo		epi	deon	teleo		epi	deon	teleo
weak	✓	✓		weak		✓	✓	weak	✓		
strong	✓	✓		strong	✓	✓		strong		✓	
	(a)				(b)				(c)		

Table 1 Three hypothetical modals, one satisfying IFF (convexity) (a), one satisfying path-connectedness but not IFF (b), and one satisfying neither (c). A ✓ in a cell of the table indicates that the corresponding force-flavor pair belongs to $\llbracket m \rrbracket$.

¹² We are grateful to Jakub Szymanik (p.c.) for making this suggestion.

¹³ The name comes from the mathematical notion of path-connectedness, which states that any two points in a space are connected by a path. This is strictly weaker than convexity.

5 Conclusion

This paper has articulated a new semantic universal for modals: the Independence of Force and Flavor (IFF) and demonstrated that it makes sound typological predictions: (i) highly underspecified modals and attitude verbs, which are incompatible with the SAV universal, do satisfy IFF; (ii) highly unnatural modal meanings are still ruled out; (iii) maximally specified modals also satisfy IFF. It can also be seen as a form of convexity in the domain of modals. At the present time, we know of no counterexamples to this universal, which captures in a theory-neutral way a principle that has guided semantic theorizing on modals since [Kratzer 1977, 1981](#).

Future work will thus take IFF as an explanatory target in theorizing about the semantic typology of modality. On the empirical side, gathering and systematizing the existing excellent cross-linguistic work on modality will enable large-scale verification (or refutation) of IFF and other properties. On the theoretical side, one would like to explain *why* modals satisfy this property. Promising avenues here include learnability ([Steinert-Threlkeld & Szymanik 2019, 2020](#), [Steinert-Threlkeld 2020](#), [Chemla, Buccola & Dautriche 2019](#)) and/or efficient communication ([Kemp & Regier 2012](#), [Kemp, Xu & Regier 2018](#), [Zaslavsky et al. 2018](#), [Gibson et al. 2019](#), [Denić, Steinert-Threlkeld & Szymanik 2020](#), [Steinert-Threlkeld 2021](#), [Zaslavsky, Maldonado & Culbertson 2021](#), [Uegaki 2021](#)).

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