Formal features for a syntactic-semantic classification of predicative adjectives in Brazilian Portuguese

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Abstract. Syntactic-semantic classification of words relies ultimately on the selection of appropriate formal features. This is a bibliographic study discussing the applicability and relevance to Brazilian Portuguese of features proposed to correlate to semantics in large-scale work on predicative adjectives. These include distributional features of subjects, complements, prepositions, and copular verbs, as well as transformational features (i.e., those obtained by information-preserving rephrasing of sentences). The results of this bibliographic search suggest that 40 of the formal properties registered in other work are promising for dividing Brazilian Portuguese adjectives into syntactic-semantic classes.

1. Introduction

Large-scale efforts for a syntactic-semantic classification of Brazilian Portuguese (BP) predicates focus mainly on verbs [Cançado et al. 2018] and nouns [Barros 2014], [Santos 2015], [Calcia 2022], [Rassi 2023]. Predicative adjectives (A_{pred}), nonetheless, are so far an underexplored phenomenon when it comes to large-scale classification of BP predicates.

Such adjectives select the arguments in sentences with copular verbs. A transformational property – i.e., the acceptability of an information-preserving rephrasing – characterizes A_{pred}: its use in adnominal function should be equivalent to a relative clause consisting of a copular verb plus the adjective [Vendler 1968]: *um aluno ansioso para voltar pra casa* (a student anxious to go home) = *um aluno que está ansioso para voltar pra casa* (a student who is anxious to go home).

Large-scale studies on the syntax-semantics of A_{pred} depend on the identification of relevant formal properties. Since natural language sentences constitute an infinite set, with an ever-growing lexicon [Harris 1991], the number of properties a predicate might show cannot be grasped in its entirety. Additionally, not all of them are correlated to semantics. Different and complementary approaches can be used to define relevant features. Bibliographic research is the most fundamental of such approaches, saving the researcher from spending a long time with corpus research and introspection only to rediscover correlations. Systematic descriptions of European Portuguese and other languages are available and their findings might prove useful for identifying such features.

The objective of this paper is thus to provide a discussion of formal properties employed in large-scale work for the classification of A_{pred}. This is expected to point out directions for large-scale studies of BP A_{pred}.

2. The studies

The discussion on formal features of adjectives and their correlation with semantic features is too extensive to be compiled in its entirety. Also, part of these studies are in languages we have no access to. To make this study possible, we have included exclusively works in Portuguese, French, or English that classify over a thousand A_{pred}, i.e., large-scale investigations into this type of predicate, which we believe to make assertions with strong empirical support. Although this leaves aside theoretically important accounts of adjectives, such as [Vendler 1968], such texts are contemplated indirectly, since their key ideas are applied to the empirical investigations described in our sources.

The selection led to a body of six studies. All of them follow the Lexicon-Grammar theoretical and methodological framework, which proposes the registration of properties of natural language predicators in matrices [Gross 1975] [Gross 1981]. One of them [Valetopoulos 2003] combined Lexicon-Grammar with the *classes d'objets* framework [G. Gross 1994], which aims at registering the semantic types of arguments. A qualitative and quantitative synthesis of these studies is provided in Table 1.

Table 1. Languages, objects, lexemes, features, and classes per large-scale study of predicative adjectives

Reference	Target language(s)	Object	Number of lexemes	Number of features	Number of classes
Picabia 1978	French	All A_{pred}	"Around 4,000"	86	16
Casteleiro 1981	European Portuguese	A_{pred} with complement clauses	2,039	47	11 (+3 subclasses)
Nam 1996	Korean	All A_{pred}	6,500	unspecified	15
Valetopoulos 2003	Greek and French	All A_{pred}	unspecified (around 7,000 estimated)	unspecified	unspecified
Carvalho 2007	European Portuguese	Intransitive A_{pred} with human subjects	4,250	unspecified	4 (+12 subclasses)
Messina 2019	Italian	A_{pred} with complement clauses	1,732	unspecified	10

We have searched each of these six studies for discussions on formal properties having semantic counterparts, verifying through introspection and corpora whether their application to BP is of relevance. As expected in bibliographic research involving multiple languages, all proposals discussed constructions or syntactic-semantic correlations which are not observable in BP. These are omitted from this paper due to

space restrictions. The results are presented in two sections: one discussing distributional features and the other dealing with transformational features.

3. Distributional features

In Lexicon-Grammar, distributional features are those of base sentences, i.e., sentences containing a predicate, its subject (N_0), complements (N_1, N_2), and obligatory grammatical elements, such as copular verbs (V_{cop}) and prepositions (Prep), in an unmarked order [Harris, 1968], [Harris, 1991]. In Portuguese, the base sentences of A_{pred} can be characterized as follows [Casteleiro 1981], [Carvalho 2007], with optional elements between parentheses: *N_0 V_{cop} A_{pred} (Prep N_1)*.

In BP, both N_0 and N_1 may be human (N_{hum}), non-human (N_{-hum}), finite clauses (*Que F*), infinitive clauses (V_{inf}), factive clauses (*o fato de que F* or *o fato de V_{inf}*) or, more rarely, conditional clauses (*se F*). Both finite and factive finite clauses can be either in the indicative (F_{ind}) or subjunctive (F_{sub}) mood. Arguments of the type N_{hum} are usually defined as those accepting substitution with given names or certain interrogative pronouns which translate to English "who" (in BP, *quem*); N_{-hum} covers arguments which do not pass these tests. Since N_{hum} and N_{-hum} are defined through formal criteria, they count as formal properties.

Psychological predicates are sure to accept N_{hum} (not exclusively) at least in one type of sentence, since psychological states are by definition human manifestations [Gross 1975], [Casteleiro 1981]. This applies to A_{pred} such as *alegre* (happy), *assustado* (scared), and *cansado* (tired). The same is true of A_{pred} denoting human behavior [Nam 1996], such as *inteligente* (clever) and *corajoso* (brave), and A_{pred} denoting nationalities, philosophical positions, and diseases [Carvalho 2007].

Alternation between N_{hum} and clauses in subject position has been associated with human behavior predicates [Nam 1996]: both *Maria é assustadora* (Maria is scary) and *é assustador entrar numa caverna* (it is scary to go into a cave) are acceptable sentences, but the latter is unacceptable for predicates taking an experiencer subject: **é assustado entrar numa caverna* (*it is scared to go into a cave). Behavior A_{pred} are said to only accept subject clauses if they are also evaluative A_{pred} [Valetopoulos 2003]. Thus, *é horrível que ele se comporte assim* (it is horrible that he behaves like this) is acceptable, but **é severo que ele se comporte assim* (*it is severe that he behaves like this) is not. Acceptability of the latter can be increased by adding *da parte de* ("of" as in "it is bold of you to assume this"). Relatedly, intransitive A_{pred} with subject clauses have also been associated to evaluation or appreciation by the speaker [Messina 2019], such as in *é certo fazer críticas construtivas* (it is right to make constructive criticism).

Adjectives denoting extrinsic properties of human beings, including "states of mind", usually accept both finite and infinitive object clauses, which distinguishes them from other A_{pred} with human subjects [Messina 2019]. This can be exemplified by the fact that both *estou ansioso para o meu time ganhar* (I am anxious for my team to win) and *estou ansioso para que meu time ganhe* (I am anxious for "that my team wins") are acceptable sentences, whereas **estou capacitado para que ganhe* (*I am skilled that I win) sounds odd in comparison with *estou capacitado para ganhar* (I am skilled to win).

In turn, adjectives accepting non-propositional N_{-hum} subjects (not exclusively) have been associated with predicates describing information from the five senses:

vision, hearing, taste, smell, and touch [Nam 1996]. In BP, these are exemplified by, respectively, *quadrado* (square), *grave* (low-pitched), *doce* (sweet), *cheiroso* (scented), *áspero* (rough). It is not uncommon for these adjectives to accept human or propositional subjects also in a metaphorical sense: *doce* might mean "pleasant" when it extends to propositions, e.g., *é doce andar no parque* (walking through the park is sweet), and "gentle" when it applies to human beings: *Carlos é um rapaz muito doce* (Carlos is a very sweet young man).

Factive clauses have been associated with predicates imprinting a semantically factive reading on its subordinate clauses [Gross 1975], [Picabia 1978], [Casteleiro 1981]: *o fato de João ter ido embora é comprometedor* (the fact that João is gone is compromising) entails *João foi embora* (João is gone). There seems to be a subclass of intransitive A_{pred} denoting different degrees of truth values [Picabia 1978], [Messina 2019], such as *verdadeiro* (true), *provável* (likely), and *falso* (false), which accepts only non-factive subject clauses. Relatedly, in finite complement clauses there is a tendency for the subjunctive mood to be used with non-factive A_{pred} denoting uncertainty or subjectivity, whereas the indicative is related to factual propositions [Casteleiro 1981]: *é bom que o João compra arroz* (it is good that João buys rice) entails that João buys rice, whereas *é bom que o João compre arroz* (it is good that João buy rice) does not. Finally, the small set of A_{pred} introducing their clauses with *se* (if/whether), such as *incerto* (uncertain) or *duvidoso* (doubtful), was suggested to convey doubt [Casteleiro 1981], [Messina 2019].

Acceptability of both subject and object clauses is associated to A_{pred} denoting equivalence, which are said to be symmetrical, i.e., inverting subject and complement conveys the same information [Picabia 1978], [Casteleiro 1981], [Nam 1996], [Messina 2019]. In BP, this behavior can be observed in A_{pred} such as *equivalente a* (equivalent to) and *parecido com* (similar to): *andar de moto é parecido com andar de bicicleta* (riding a motorcycle is similar to riding a bike) conveys the same information as *andar de bicicleta é parecido com andar de moto* (riding a bike is similar to riding a motorcycle).

Physical and psychological human state A_{pred} can be distinguished by the acceptance of non-coreferential causative clauses [Valetopoulos 2003]. In BP these are introduced with preposition *de*, as in *Pedro está cansado de discutir esse assunto* (Pedro is tired of discussing this issue). **Pedro está cansado de a Maria discutir esse assunto* (*Pedro is tired of Mary discussing this issue) is marginal at best, but both *Pedro está triste de descobrir isso* (Pedro is sad to find that out) and *Pedro está triste de a Maria ter descoberto isso* (Pedro is sad for Maria to find that out) are acceptable.

Portuguese has two copular verbs: *ser* and *estar*. Although these are commonly assumed to relate, respectively, to inherent and accidental adjectives, it has been shown that this is context-dependent [Casteleiro 1981], [Carvalho 2007]. Still, A_{pred} with object clauses participating in volitive constructions (such as the imperative) mostly accept *ser*, whereas those which do not accept these constructions form sentences with *estar*, e.g., *seja hostil!* (be hostile!) is quite acceptable, but *?esteja ansioso!* (?be anxious!)[1] has much lower acceptability [Casteleiro 1981]. Also, nationality and belief adjectives

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[1] We use question marks before sentences to indicate low, but non-zero, acceptability.

accept *ser*. This verb generally combines with congenital or chronic diseases, whereas *estar* occurs with temporary ones [Carvalho 2007].

A subclass of A_{pred} which selects exclusively locative complements has been proposed [Picabia 1978]. These are all stative, with no assignment of source, path, or destination semantic roles [Nam, 1996]. In BP, they correspond to A_{pred} such as *próximo a* (next to), *paralelo a* (parallel to), and *exterior a* (external to). Prepositions *a* and *em* seem to be common choices with these adjectives, but others, such as *de* (*perto de* "near to"), are not impossible. Adjectives denoting orientation [Nam 1996] will usually take *para* N_{-hum}: *a torre está (inclinada + voltada) para um prédio* (the tower is (inclined to + facing) a building).

When preposition *para* introduces N_{hum}, these are commonly experiencers. The same adjectives which accept this *para* also accept *da parte de* (roughly "of" as in "it is bold of you to assume this") introducing stimuli [Casteleiro 1981]. Acceptance of *da parte de* has been associated also to behavior A_{pred} [Messina 2019]. This alternation can be shown, e.g., in *interessante* (interesting): *apresentar esse seminário foi interessante para a Maria* (presenting this seminar was interesting for Maria) means that Maria found the experience of presenting the seminar interesting; *apresentar esse seminário foi interessante da parte da Maria* (it was interesting of Maria to present this seminar) means that the speaker found the stimulus "Maria presented this seminar" interesting.

Korean has a different type of alternation between experiencer and stimulus using postpositions, in which the stimulus is not necessarily a participant in a complement clause [Nam 1996]. Certain adjectives, such as *indiferente* (indifferent) have similar alternations in BP which might be worth testing: *Zé é indiferente a viajar de avião ou de ônibus* (Zé is indifferent to travelling by plane or by bus) is more or less equivalent to *viajar de avião ou de ônibus é indiferente para o Zé* (travelling by plane or by bus is indifferent to Zé). A large-scale study is required to pinpoint how widespread this alternation is in BP.

When *para* introduces complement clauses rather than human or non-human nouns, it usually denotes a purpose for N_0 [Casteleiro 1981], e.g., *João é (importante + útil) para resolver essa questão* (João is (important + useful) to solve this issue). Also, certain A_{pred} have subjunctive complement clauses introduced by *por* in European Portuguese which can be reduced to infinitive clauses when subordinate and matrix subjects are coreferential. These usually convey desires and their complement clauses always denote future propositions [Casteleiro 1981]. In BP, although *por* is acceptable, these seem to be more common with *para*: *Zé está (ansioso + louco + desesperado) (para viajar + para que Maria viaje)* (Zé is (anxious + crazy + desperate) (to travel + for Maria to travel)).

Ability A_{pred} are suggested to have prepositions in common in French (*à*) [Picabia 1978] and Italian (*di*) [Messina 2019]. In BP, these can be identified with a subset of A_{pred} accepting *em* (in) plus infinitive clause: *Ana é (hábil + eficiente + boa) em resolver problemas* (Ana is (skilled + efficient + good) in solving problems)

Certain adpositions have been noted to introduce "beneficiary" (or possibly "maleficiary") complements of A_{pred} denoting human behavior [Nam 1996], [Carvalho 2007]. In BP, *com* (with) and its formal variety *para com* (roughly "towards") seem to play this role: *Zé foi grosseiro (para + E) com Ana* (Zé was rude towards Ana).

4. Transformational features

A transformation in Lexicon-Grammar can be briefly defined as a regular relation between two paraphrastic sequences employing the same content morphemes [Harris 1968], [Harris 1991]. Common examples of transformations are passivization, relativization, and zeroing. We explore in this section transformations of A_{pred} pointed out as relevant for lexical semantics.

Appropriate nouns (N_{ap}) are those which can be erased in an argument without changing the information conveyed by the sentence. For example, *o comportamento da Ana é agressivo* (Ana's behavior is aggressive) and *a Ana é agressiva* (Ana is aggressive) mean roughly the same; in this case, *comportamento* (behavior) counts as an N_{ap}, since it is highly likely in this environment and may be zeroed with no loss of information [Harris 1991]. Acceptance of N_{ap} *comportamento* is distinctive of behavior predicates, but several other N_{ap} exist and classification based on them might lead to particularly fine-grained classes [Valetopoulos 2003]. Adjectives with N_{-hum} subjects can be classified as relating to the different five senses based on their N_{ap} [Nam 1996]: *essa mesa é quadrada* (this table is square) = *o formato dessa mesa é quadrado* (the shape of this table is squared) conveys visual information; *esse queijo é fedido* (this cheese is stinky) = *o cheiro desse queijo é fedido* (the smell of this cheese is stinky) conveys olfactory information, etc.

Psychological A_{pred} generally correspond to sentence adverbs, whereas evaluative and behavior A_{pred} mostly correspond to either subject or object-oriented verb-modifying adverbs [Nam 1996]. This distinction can be verified by observing how well an adverb accepts a certain position. Psychological deadjectival adverbs can be sentence starters more easily: *infelizmente, o Zé respondeu à pergunta* (unfortunately, Zé answered the question); however, they sound like an interruption if closer to the verb: *?o Zé respondeu infelizmente à pergunta* (?Zé answered unfortunately the question). Evaluative and behavior deadjectival adverbs show the opposite behavior: *o Zé respondeu (corretamente + corajosamente) à pergunta* (Zé answered (correctly + bravely) the question) is perfectly acceptable, but (?*corretamente + corajosamente), o Zé respondeu à pergunta* ((correctly + bravely), Zé answered the question) have different overtones. This, however, does not seem to apply to A_{pred} with object clauses: e.g., *ansiosamente* (anxiously) is necessarily a verb modifier. Unacceptability of degree and manner adverbs was shown to be distinctive of nationality A_{pred} in European Portuguese [Carvalho 2007], which seems to also hold for BP.

Many intransitive A_{pred} can be characterized through their relation with nouns introduced by a possessive verb in relative clauses denoting a part-whole relation [Picabia 1978]: *barbado* (bearded) = *que tem barba* (that has a beard), *espinhoso* (thorny) = *que tem espinhos* (that has thorns). Both quality (e.g., *corajoso* "brave") and material (*dourado* "golden") A_{pred} have been suggested to correspond to certain constructions with V_{cop} plus preposition [Valetopoulos 2003]; in Portuguese, this sequence is *ser de* (to be of): *essa mulher é de uma enorme coragem* (this woman is of an enormous courage) = *essa mulher é muito corajosa* (this woman is very brave). Another type of nominalization distinguishes "disposition" A_{pred}, whose nominal version might occur in certain locative constructions [Valetopoulos 2003], such as with BP *invadir* (invade): *o cansaço invadiu Pedro* (tiredness invaded Pedro) = *Pedro ficou cansado* (Pedro got tired).

A correspondence between certain preposition plus clause segments and causative constructions has also been pointed out as a property of A_{pred} denoting psychological phenomena [Nam 1996] or "states of mind" [Messina 2019]: *Lia está contente de ir a Paris* (Lia is happy to go to Paris) = *Ir a Paris deixa a Lia contente* (Going to Paris makes Lia happy).

Aspectual pseudocopulas have been mentioned as widely accepted by disease A_{pred}, whereas only *tornar-se* (become) was characteristic of nationality and philosophical A_{pred} [Carvalho 2007]: e.g., *Zé (ficou + permanece + tornou-se) doente* (Zé (got + remains + became) sick), but *Zé (*ficou + *permanece + tornou-se) brasileiro* (Zé (*got + *remains + became) Brazilian). S*entir-se* (feel) was observed to be equivalent to *estar* only in combination with "psycho-physiological" A_{pred} [Valetopoulos 2003], [Carvalho 2007]: *Zé se sente cansado* (Zé feels tired) = *Zé está cansado* (Zé is tired); however, *sentir-se* and *estar* lead to different meanings with non-psychological A_{pred}: *Zé sente-se prestes a conseguir um aumento* (Zé feels about to get a raise) ≠ *Zé está prestes a conseguir um aumento* (Zé is about to get a raise).

Certain verbs taking A_{pred} as arguments (find, consider) are said to apply only to psycho-evaluative adjectives [Nam 1996]. This is similar to BP *achar*, which is common with A_{pred} such as *suspeito* (suspect), *bom* (good), or even *alto* (tall), but seem less likely with *prestes a* (about to) or *sujeito a* (subject to).

"Object raising" or "tough movement" is the operation of moving the object of a complement clause to the subject position of the main clause, e.g. *É fácil agradar o Zé* (It is easy to please Zé) = *O Zé é fácil de agradar* (Zé is easy to please). Adjectives accepting this transformation are not associated to the same semantic properties by all of our sources: for French, they are said to be "appreciative" of the movable argument, whereas the ones that do not accept object raising are "descriptive" [Picabia 1978]; alternatively, these A_{pred} are said to denote the speaker's "affective or emotional position" towards a proposition [Casteleiro 1981], in European Portuguese, or to evaluate both the action denoted by the subordinate clause and the raised object, in Korean [Nam 1996]. These A_{pred} have also been associated to the concept of difficulty in Italian [Messina 2019]. A large-scale study is required to pinpoint the semantic properties object raising might map to in BP.

A possibly overlapping transformational property is the acceptance of exclamative clauses such as *que espantoso!* (how astonishing!), *que horrível!* (how horrible!), etc., all of which convey the speaker's emotions towards its (implied) subject. Additionally, it has been suggested that A_{pred} accepting this property are commonly factive, accept subjunctive clauses, and correspond to causative constructions: *espantoso* (astonishing) = *que causa espanto* (that causes astonishment) = *que espanta* (which astonishes). These are called "emotive adjectives" [Casteleiro 1981].

In European Portuguese over 50% of intransitive A_{pred} with N_{hum} subject may also be employed as nouns, most of which (80%) denote negative physical or psychological properties: *burro* (dumb), *idiota* (idiot), etc. Negative adjectives are also common after verbs like *chamar* (call, as in "Mary called him stupid") and exclamative constructions with *seu* (literally "your", interpreted as "you" in sentences such as "you bastard!") [Carvalho 2007]. These constructions seem to have the same connotations in BP.

Adjectives denoting nationalities, beliefs, and diseases do not accept the pre-nominal position [Carvalho 2007]: *brasileira mulher* (Brazilian woman). The pre-nominal position is widely studied and usually associated to emotion and subjectivity in Brazilian grammars, but no comprehensive study such as those carried out in Lexicon-Grammar seems to have dealt with this subject in BP.

Intersective versus non-intersective adjectives is a well-known semantic division which has a formal counterpart: *um carro vermelho* (a red car) is intersective because it implies *algo que é um carro e é vermelho* (something which is a car and red); on the other hand, *um professor bom* (a good teacher) does not imply *alguém que é um professor e é bom* (someone who is a teacher and is good), but *alguém que é bom como professor* (someone who is good as a teacher). Shape (*oval*), nationality and social group (*grego* greek, *católico* catholic), and color (*vermelho* red) adjectives are said to be intersective, whereas denominal (*polar*), manner (*rápido* fast), emotion (*pobre menino* poor boy), and modal adjectives (*antigo* former) are non-intersective [Valetopoulos 2003].

Truth value A_{pred} can commonly be paraphrased with a different structure in which the adjective applies to the second element of a sentence with *ser* (be): *é possível que João seja professor* (it is possible that João is/will be a teacher) = *João é um possível professor* (João is a possible teacher) [Messina 2019].

5. Final remarks

This paper synthesized how observations from large-scale work on the syntax-semantics of predicative adjectives can provide promising features for a description of these predicates in Brazilian Portuguese. We have discussed 40 formal features: 8 distributional features applying to both arguments, totaling thus 16 features, plus two possibilities of copular verb, alternation of prepositions (counted here as a single property), number of arguments, and 20 transformational features. The exact role of all 40 properties in the semantics of Brazilian Portuguese is not completely clear, as the studies diverge on certain correlations and not all of them apply directly to Brazilian Portuguese. This study should thus be taken only as providing directions for a large-scale study of Brazilian Portuguese predicative adjectives, and not as an attempt of classification all by itself.

In addition, these are not the only properties that can be used to characterize predicative adjectives. Other recent references on Brazilian Portuguese have been discussing the semantics of formal properties applying to smaller sets of adjectives. Testing them in a larger lexicon might prove useful for adjective classification and their collection is recommended as a subsequent task. Also, irregularities are expected in how syntax and semantics relate, as it has been repeatedly reported in this type of study. Still, the features discussed in this paper presented substantial semantic correlations in other studies and can provide a solid foundation for a similar syntactic-semantic classification of Brazilian Portuguese predicative adjectives.

Acknowledgements

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