

# **A Bayesian Analysis of the Transitivity Hypothesis: Global Transitivity as a Predictor of Spanish Causatives**

**Gustavo Guajardo**

**Abstract:** This paper contributes to the understanding of causative constructions by comparing the two main causative predicates in Spanish *hacer* ‘make’ and *dejar* ‘let’ in relation to the semantic characteristics of the linguistic contexts in which they appear. To achieve this, I use Hopper and Thompson’s (1980) Transitivity parameters and other linguistic features such as the case of the clitic in the causative construction and the person features of the causative verb to characterize different aspects of the elements involved in causative constructions. The analysis is conducted on a dataset with over 4500 sentences taken from Corpus del Español (Davies 2002), which was analysed by means of two Bayesian mixed-effects logistic regression models and a random forest for variable importance. The analysis reveals very clear and distinct semantic profiles of each causative and suggests that the elements comprising Transitivity, understood as a global property of the clause, are very good predictors of which causative predicate is most likely to be used in a given context.

## **1 Introduction**

Romance causatives have received a great deal of attention in linguistic theory both from a comparative perspective across the Romance languages as well as within each language, but there is not much research comparing the two Spanish causatives *hacer* ‘make’ and *dejar* ‘let’. This paper aims to contribute to our understanding of causative constructions by analyzing a large dataset with over 4500 sentences with *hacer* and *dejar* by means of sophisticated statistical models.

The causative construction this paper is concerned with is one in which the causative takes an infinitival complement and the subject of the infinitive is realized as a clitic (1-a-b).<sup>1</sup>

1. a. [...]      los            hace            abandonar      el            mundo.  
                       them.ACC    make.3S      abandone.INF    the.MASC    world  
                       ‘It makes them abandon the world’  
                       (Costa Rica: 4)

- b. Lo            dejó            abordar      un            autobús.  
                       him.ACC      let.3S.PAST    aboard.INF    a.MASC      bus  
                       ‘He let him get on a bus’  
                       (Cuba: 10)

In (1a) the causative *hacer* ‘to make’ is preceded by the clitic *los* ‘them’ and followed by the infinitive *abandonar* ‘to abandon’. In (1b) the causative *dejar* ‘to let’ is preceded by the clitic *lo* ‘him’ and followed by the infinitive *aboard* ‘to aboard, to get on’. In both cases, the clitic in the matrix clause is the logical subject of the infinitival clause.

A peculiarity of this construction is that the third-person clitic can appear in either the accusative (2a-3a) or the dative case (2b-3b).<sup>2,3</sup>

2. a. La            esperanza    los            hace            andar.  
                       the.FEM      hope          them.ACC    make.3SG    go.INF  
                       ‘Hope keeps them going’  
                       (Argentina: 82)

- b. Le            hicieron      pasar.  
                       him.DAT      make.3PL    pass.INF  
                       ‘They had him go in.’  
                       (Ecuador: 494)

3. a. Luego      lo            dejó            aterrizar      en      Canarias.  
                       then          him.ACC    let.3SG.PAST    land.INF      in      Canarias  
                       ‘Then he let him land in Canarias’  
                       (Venezuela: 323)

<sup>1</sup> The number next to the country refers to the ID code in the dataset

<sup>2</sup> The third-person is the only person that distinguishes between accusative and dative case.

<sup>3</sup> Although the examples in (2-3) all contain intransitive predicates the same case variability is found with transitive predicates.

- b. No les dejaban entrar.  
 Not them.DAT let.3PL.PAST enter.inf  
 ‘They wouldn’t let them in’  
 (Bolivia: 2029)

The generalization has been that intransitive verbs take an accusative clitic and transitive verbs a dative clitic (e.g., Comrie 1976, Aissen and Perlmutter 1983, Rosen 1990). However, Spanish case marking is more problematic because both animate direct objects and dative objects are marked with the marker *a* so the transitive/dative and intransitive/accusative correspondence does not always obtain and case marking of the clitic is highly variable (Labelle 2017). Some have proposed that the difference in case can be explained by directness of causation (Strozer 1976, Treviño 1994, Enghels 2012). For example, if an intransitive predicate appears with a dative clitic then the causation is considered indirect. Likewise, a transitive predicate with an accusative clitic is said to mark direct causation (Strozer 1976, Moore 2010). Another observation regarding clitic case has been that *hacer* imposes selectional restrictions on accusative causees but not on dative ones (Moore 1996). According to Moore (1996), when *hacer* takes an accusative clitic object the referent must be animate (4a); an inanimate accusative clitic is ungrammatical (4b). In contrast, no such restrictions hold with dative clitics (5).

4. a. Juan la hizo esconder.  
 Juan her.acc made.3S hide.inf  
 ‘Juan made her hide’ or ‘Juan had someone hide her/it.’
- b. \*Juan lo hizo perder agua al coche  
 Juan him.acc made.3S lose.inf water to.the.MASC car
5. Juan le hizo perder agua al coche.  
 Juan him.DAT made.3S lose.INF water to.the.MASC car  
 ‘Juan made the car lose water’

(4a) is ambiguous depending on the syntactic function assigned to the clitic *la* ‘her’. In one reading *la* ‘her’ is the subject of the embedded verb *esconder(se)* ‘to hide’ and the clitic can

only have an animate referent. In the second reading, *la* is the object of the infinitive and it can have an animate or an inanimate referent. In (4b), the clitic is the subject of the infinitive *perder* ‘to lose’ and the referent *el coche* ‘the car’ is inanimate so this sentence is ungrammatical. In (5) the clitic is realized in the dative case so it is free to have an inanimate referent. However, I personally do not share these judgements, for example in (6) the clitic is in the accusative with *hacer* and the sentence sounds perfectly grammatical.

6. Lo	hice	arrancar	enseguida.
it.ACC	made.1S.PAST	start.INF	right.away
‘I made it start up right away’			

In (6) the clitic *lo* is singular masculine and accusative and the most natural way to interpret the sentence is that I made a machine, possibly a car, start right away. I return to this issue in section 7.2.

An advantage of using a large sample of naturalistic data and statistical modelling is that we can directly test theoretical claims like the ones we just discussed. For example, if it is true that case marking and causation type are correlated, we should expect a statistically significant interaction between the two. If we find that such interaction exists, then we have found empirical support for the theoretical proposal. On the other hand, if the interaction were not to be found then we would need to refine our theoretical analysis of case alternation in causative constructions and the statistical model can point us to a plausible alternative explanation.

## 2 The causatives *dejar* and *hacer*.

Although most work on Spanish causatives has focused on the study of *hacer*, there is a small number of papers that discuss the two causatives *hacer* and *dejar* by comparing their behaviour with respect to different semantic and syntactic features. I will describe some of their findings below and discuss how the present work can build and shed more light on our current knowledge of these predicates.

Ruiz-Sánchez (2006) compares *dejar* and *hacer* against Vendler's (1967) lexical aspect of the infinitive verb (i.e., states, activities, accomplishments and achievements). The data come from examples created by the author to illustrate the contexts in which each causative is likely to appear and the analysis is restricted to animate subjects. She concludes that causative *hacer* implies intentionality, direct causation and unwillingness of the causee for the event to take place. As for the type of lexical aspect, she claims that *hacer* makes reference to the whole event for states, accomplishments and achievements but with activities the causative makes reference to the beginning of the event. In addition, states, accomplishments and activities imply high involvement of the causer whereas achievements denote low involvement. Causative *dejar* shares with *hacer* the fact that it also implies intentionality on the part of the causer, but contrary to *hacer*, *dejar* refers to indirect causation, willingness and control of the causee for the event to happen and low causer involvement across the four lexical aspectual categories. Moreover, while *hacer* makes reference to the whole event for all types of events except for activities, *dejar* makes partial reference to the event because it refers to events that are already ongoing. The exception to this observation is achievement predicates for which *dejar* describes the entirety of the event.

Engels (2012) studies both causative constructions in relation to the differences between positive and negative causation and the case marking of the causee realized as a clitic. The data come from CREA (*Corpus de Referencia del Español Actual* 'Corpus of Reference of Contemporary Spanish') (RAE 2008) and the analysis is limited to Peninsular Spanish. They observe that the case of the clitic is independent of the transitivity status of the infinitive verb. They follow Soares da Silva (2001) in distinguishing *hacer* from *dejar* in terms of positive and negative causation, respectively and aim to establish whether this semantic difference can be tied to the variability in the clitic's case. Their point of departure is the claim that accusative clitics denote direct causation whereas dative clitics express indirect causation (e.g., Moore

1996). They conclude that when the causer lacks control or coercion (e.g., inanimate subjects) then *hacer* favours the dative clitic whereas the reverse is true for the accusative clitic. They also find that the behaviour of *dejar* is more complex because the case of the clitic depends on the specific semantics the causative expresses. They identify three basic meanings: (i) “to cause” prefers accusative, (ii) “not to permit” prefers dative when it means “not to oppose” case assignment is dependent on the semantics of the subordinate event. Overall, they report that the dative is found more often than the accusative clitic with both causatives regardless of whether the verb is transitive or intransitive.

In a comparative study, Enghels and Roegiest (2012) compare *dejar* with infinitival or subjunctive complement clauses in a sample of 1000 sentences from CREA. They find that *dejar* mostly appears with animate subjects (80%) but the subject is not always in control as with *hacer*. They relate this lack of control on the part of the subject to the frequent use of *dejar* in their data with intransitive verbs and inanimate causees. In addition, they report that *dejar* appears mostly with a dative clitic. When the accusative clitic is used, the object tends to be either inanimate or feminine.

While these studies highlight important characteristics of the causative constructions, the methodologies impose some limitations to the generalizations observed. Ruiz-Sánchez’s (2006) study focuses only on animate subjects and the examples are constructed by the author. While the sentences discussed in the paper may be grammatical in their own right this does not preclude that other possible sentences could potentially be found with naturalistic data that would support a different conclusion, a fact that undermines the generalizations made in the paper because one single sentence per condition is simply not enough data to rely on. An important caveat of Enghels (2012) and Enghels and Roegiest (2012) studies is the focus on Peninsular Spanish. As mentioned in footnote (10) in Enghels (2012: 22), Peninsular Spanish uses the dative clitic for masculine animate *direct* objects (this phenomenon is known as *leísmo*)

so use of the morphologically dative clitic cannot be interpreted as marking the causee as an indirect object.<sup>4</sup> This makes the data difficult to interpret and therefore weakens the conclusion for example, that both causatives prefer the dative clitic. Methodologically, although both studies are a good move in the right direction by using corpus data instead of examples created by the researcher, no analysis of statistical significance is conducted so it is difficult to assess whether the percentage differences reported are significant in a statistical sense.

The present study addresses these issues by using a relatively large data sample of over 4500 sentences from a corpus of 19 Spanish-speaking countries. Fundamentally, Peninsular Spanish is not included in the sample for the reasons just explained about *leísmo*. Moreover, the data will be analysed with three different statistical models, which together will provide us with a fine-grained understanding of the linguistic elements involved in causative constructions.

To conduct the statistical analysis we need a set of predictor variables that we believe might be relevant in the characterization of these causative verbs. In the next section, I introduce the theoretical framework that will allow us to have a well-defined and motivated set of such variables.

### **3 The Transitivity Hypothesis**

In a seminal paper, Hopper and Thompson (1980) develop the proposal that transitivity is best understood as a property of the whole clause and can be broken down into a number of subcomponents or parameters.

They propose ten parameters in total. All the parameters are binary, except for INDIVIDUATION, which subsumes a number of semantic features of the object. The parameters

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<sup>4</sup> As Ormazabal and Romero (2010) point out, *leísmo* is a term that covers a wide range of phenomena. Some Peninsular dialects do not distinguish between animate or inanimate objects and use the dative clitic both for direct and indirect objects. Other dialects make this distinction and restrict the dative clitic to animate masculine objects (e.g., Landa 1995, Fernández Ordoñez 1999, Bleam 2000).

are shown in Table 1 and the features of the object comprising INDIVIDUATION are shown in Table 2.

Table 1. The subcomponents of Transitivity in Hopper and Thompson (1980).

<b>Component</b>	<b>High</b>	<b>Low</b>
PARTICIPANTS	2 or more	1
KINESIS	action	non-action
ASPECT	telic	atelic
PUNCTUALITY	punctual	non-punctual
VOLITIONALITY	volitional	non-volitional
AFFIRMATION	affirmative	negative
MODE	realis	irrealis
AGENCY	A high in potency	A low in potency
AFFECTEDNESS OF O	totally affected	not affected
INDIVIDUATION OF O	highly individuated	non-individuated

Table 2. Semantic features of the object subsumed under INDIVIDUATION.

<b>Individuated</b>	<b>Non-Individuated</b>
proper	common
human, animate	inanimate
concrete	abstract
singular	plural
count	mass
referential, definite	non-referential

The parameter PARTICIPANTS refers to whether the predicate is transitive or intransitive such that a transitive predicate is higher in Transitivity than an intransitive one. KINESIS describes the predicate of a clause and distinguishes between states (non-action) and non-states (action) and suggests that non-states are more transitive than states. ASPECT is concerned with whether the predicate is telic or atelic, where telic predicates are said to be more transitive than atelic predicates. PUNCTUALITY is also concerned with aspects of the event distinguishing between



punctual and non-punctual events; punctual events are considered more transitive than non-punctual events. VOLITIONALITY refers to features of the subject of the clause, distinguishing between volitional and non-volitional subjects. Clauses with volitional subjects are considered to be higher in Transitivity. AFFIRMATION refers to whether the clause is affirmative or non-affirmative, where affirmative clauses are said to be more transitive than non-affirmative clauses. MODE concerns the modality of the clause and it distinguishes between realis and irrealis, with realis clauses considered more transitive than irrealis clauses. The next parameter is AGENCY, which refers to whether the subject of the clause is agentive or non-agentive; clauses with an agentive subject are considered more transitive than clauses with a non-agentive subject.

The last two parameters describe features of the object. AFFECTEDNESS concerns the degree to which an action is transferred to a patient. Clauses with totally affected objects are considered more transitive than those with non-affected objects. Last, INDIVIDUATION is made up of six features describing the grammatical object. For example, a concrete and count NP is more individuated than an abstract and mass NP and therefore higher in Transitivity.

Based on cross-linguistic evidence, Hopper and Thompson propose the Transitivity Hypothesis in (1).

1. If two clauses (a) and (b) in a language differ in that (a) is higher in Transitivity according to any of its subcomponents then, if a concomitant grammatical or semantic difference appears elsewhere in the clause, that difference will also show (a) to be higher in Transitivity (Hopper and Thompson 1980: 255).

The claim in the Transitivity Hypothesis is that the values of each of the Transitivity parameters will co-vary systematically. This means that if one parameter is high in Transitivity in a specific linguistic construction, then another parameter that must also be marked morphologically in the

same construction will be on the higher side of Transitivity. For example, if a language distinguishes between telic and atelic predicates in its morphology and requires overt marking of the object that appears with telic predicates (high Transitivity) then their hypothesis predicts that the objects should also bear markings of high Transitivity such as highly individuated (Hopper and Thompson 1980: 255).

Tsunoda (1985) suggests that the Transitivity Hypothesis as it stands is too strong because not all parameters can be expected to co-vary to the same degree or even to co-vary at all. For example, he argues that the correlation between AFFECTEDNESS and AGENCY is non-existent as one can kill someone with the same efficacy whether it is done accidentally or intentionally. On the other hand, he points out that VOLITIONALITY and AGENCY almost describe the same property as it is very difficult to picture a subject who is volitional but non-agentive or non-volitional but agentive (Tsunoda 1985: 392). In fact, subsequent work has proposed that volitional involvement is a prerequisite for agenthood (e.g., Dowty 1991, Lehmann 1991, Van Valin and Wilkins 1996) so it is likely that these two parameters can be replaced by a single one.

Although the Transitivity Hypothesis is concerned with obligatory morphological marking, if languages develop morphological systems in line with the Transitivity Hypothesis then we should expect to find that in general, *ceteris paribus*, languages will still show sensitivity to the Transitivity scale even in contexts where no overt obligatory marking is present. After all, obligatory morphological marking begins in iconic contexts where certain features tend to co-vary frequently (Bybee et al. 1994). For example, a language may not distinguish between count and mass nouns morphologically but speakers may still be sensitive to this distinction regardless of the lack of overt morphology, which may have consequences in various grammatical constructions. Thus, researchers have studied the effect of Transitivity in different areas of the grammar with or without obligatory morphological marking.

Winters (2004) uses Transitivity to study inalienable possession in Spanish and Romanian and Winters (2006) focuses only on Spanish. Inalienable possession in these two languages can be encoded by means of a dative possessor or a possessive determiner so the studies investigate whether choice of possessive construction is correlated with Transitivity. In Winters (2004) the analysis is conducted by means of chi-squared tests with each parameter and choice of possessive structure. The main findings reported in both studies is that AFFECTEDNESS, AGENCYSUBJ and TELICITY significantly affect the choice of possessive structure. Specifically, the dative possessor signals higher Transitivity whereas the construction with the possessive determiner correlates with lower Transitivity.

Clements (2006) uses the Transitivity parameters to investigate non-anaphoric *se* in Spanish. This clitic has a multitude of uses including reflexives and reciprocals, middle and passive voice, impersonal and antipassive constructions as well as acting as an aspectual marker. The study is focused on the non-anaphoric uses of the clitic, so not reflexive or reciprocals. Clements proposes that the clitic *se* has two distinct functions in relation to Transitivity: it can reduce Transitivity by decreasing the valency of a verb by one argument or by disallowing the appearance of a nominal or pronominal subject of an intransitive verb. Furthermore, she shows that the presence of *se* co-varies with higher Transitivity whereas the absence of it correlates with lower Transitivity. The former corresponds to aspectual differences of verbal minimal pairs with and without *se* such as *comer* ‘to eat’ and *comerse* ‘to eat up’. The forms with *se* occur with count NPs and bare plurals are not possible. The latter, that is lower Transitivity, concerns middle, passive, unaccusative, antipassive and impersonal uses of *se*.

Vázquez Rosas (2006) studies reverse psychological predicates in Spanish using the Transitivity Hypothesis. She concludes that this type of predicate exhibits low Transitivity and that the clitic case alternation characteristic of these predicates is also governed by Transitivity; higher levels of Transitivity favour accusative-marking and lower degrees of transitivity favour

dative marking. Importantly, Spanish does not differentiate in the morphology between affected or non-affected objects or telic and atelic predicates, for example, but the Transitivity parameters proved to be useful in characterizing reverse psychological predicates.

Ganeshan (2019) also investigates case alternation of Spanish clitics in reverse psychological predicates. She finds that case alternation seems to be tied to the agentivity of the subject and affectedness of the object such that accusative appears with agentive subjects and affected objects and the dative clitic with the opposite values of those two features.

As was discussed in Sections 1 and 2, semantic notions like those in the Transitivity Hypothesis have been used to account for different aspects of causative constructions. For example, animacy of the causer (i.e., INDIVIDUATION), type of lexical aspect of the infinitive (i.e., ASPECT) and level of control of the subject (i.e., AGENCY). The present study aims to make this relationship explicit by investigating the relationship between all the Transitivity parameters and the two causative predicates *dejar* and *hacer*. In the next section, I present the research questions and hypotheses based on the previous findings we have discussed so far.

#### **4 Research questions, hypotheses and predictions**

The generalizations and claims presented in Sections (1-3) allow us to formulate clear research questions, hypotheses and predictions that can be tested empirically with the help of statistical modelling. I will first introduce the guiding research questions followed by the hypotheses and I will end the section with the predictions we can expect given what has been reported in the literature. The four research questions (RQ) I try to answer are the following (note that questions (ii-iv) are dependent on (i)).

- i. Can the Transitivity parameters predict which causative will appear in a specific context?
- ii. If the answer to (i) is affirmative, are all parameters relevant?

- iii. How strong is the relationship between the Transitivity parameters and the causative construction?
- iv. Do the values of each parameter co-vary in the same direction as predicted by the Transitivity Hypothesis?

An affirmative answer to the first research question is necessary to answer all the other questions. If we discover that Transitivity is not a property that can distinguish the two causatives then we must stop there. However, if we are able to establish a relationship between Transitivity and each causative predicate then more specific questions can be pursued. RQ (ii) seeks to determine whether all or a subset of the parameters of Transitivity play a role in the characterization of the causative predicates. In answering RQ (iii) I aim to determine how predictable each causative is from the subcomponents of Transitivity. We can surmise that we may find a significant but relatively small effect of Transitivity or we may find a bigger effect, which would indicate a much stronger relationship between Transitivity and the causative predicates. The answer to this question lies ultimately in how well the model can predict the causative predicates. RQ (iv) seeks to determine the validity of the Transitivity Hypothesis in relation to the construction under investigation. We should expect that if Transitivity is found to play a role in distinguishing between the two causatives then each parameter should co-vary in the same direction in the way the Transitivity Hypothesis predicts. Based on these four research questions and previous findings I formulate the following hypotheses:

**Hypothesis 1:** The causatives *dejar* and *hacer* will be predictable from the Transitivity parameters.

**Hypothesis 2:** The causative *hacer* will be more transitive than *dejar*.

**Hypothesis 3:** The parameters will align in the same direction for each causative.

## 4.1 Predictions

The findings from previous work on the Spanish causatives that has found features such as agency and animacy of causee to be relevant aspects in causative constructions leads to the formulation of Hypothesis 1. The prediction is that each causative can be characterized accurately by assigning specific values to each parameter of the Transitivity scale. The null hypothesis is that the Transitivity parameters do not distinguish between the two causatives. If the null hypothesis is true then we do not expect the models to have a predictive power higher than chance (i.e., Accuracy should be around 0.5 for both causatives). Hypothesis 2 falls out from what we know about the semantics of *hacer* and *dejar* so we expect that *hacer* will be characterized by high values of the transitive parameters (i.e., PARTICIPANTS = *transitive*, AFFECTEDNESS = *affected*, INDIVIDUATION = *individuated*, etc.). Taking Hopper and Thompson’s proposal seriously leads to Hypothesis 3. This predicts that each of the two causatives will attract one or the other value of the parameters such that each causative will lean towards one end of the Transitivity scale. In the next section, I present the methodology employed to extract the data, how the variables were coded and the statistical methods used for the analysis.

## 5 Methodology

The statistical analysis was conducted by means of Bayesian mixed-effects logistic regression modelling and random forests of a relatively large dataset with over 4500 sentences. In what follows, I describe the methodology for data extraction and annotation as well as the details that went into model building and evaluation. The statistical analysis consists of three models, Model-1, Model-2 and Model-3, described in Section 5.2.

## 5.1 Data Extraction and Annotation

The data were extracted from Corpus del Español WebDialects and NOW versions (News on the Web) (Davies 2002). I searched for all instances of both causatives with each clitic (la + DEJAR , las + DEJAR, le + DEJAR, etc.) followed by an infinitive. The reason for using both corpora is that the web interface of the corpus only allows the user to extract 1000 hits per search. Since the accusative clitic inflects for gender as well as number this resulted in having twice as many accusative clitics than dative clitics ( $1000 \times 4 = 4000$  vs.  $1000 \times 2 = 2000$ ). Therefore, to obtain a more balanced sample I extracted 2000 more sentences with the dative clitic (1000 singular and 1000 plural) from the NOW version of the corpus. Both corpora are made up of texts from the Internet, including newspapers, blogs and general websites so it is safe to assume that they have equivalent registers for the present study. The WebDialects corpus has nearly 2 billion words and the NOW corpus has 5.5 billion words.<sup>5</sup>

The resulting dataset contained data from 21 Spanish speaking countries including the USA. Two countries were removed for the analysis. Spain was removed due to the reasons discussed in Section 3 concerning the use of the dative clitic for accusative masculine animate objects. The USA data was also removed because in the USA there are a lot of speakers from other varieties as well as non-native speakers so this would add noise to the data. After removal of duplicates and false positives the resulting dataset contained 4589 sentences where 2157 contain *dejar* and 2432 contain *hacer*, which translates into a 0.47 and 0.53 relative proportion, respectively.

Table 3. shows all the variables and the corresponding levels used in the analysis. The data were manually annotated with the Transitivity parameters except for VOLITIONALITY and two of the subcomponents of INDIVIDUATION, namely *proper names* vs. *common* and *referential* vs. *non-referential*. VOLITIONALITY was not included because as Tsunoda (1985) pointed out it

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<sup>5</sup> The NOW corpus grows monthly by around 150 million words per month. The number of words reported here corresponds to June 2020.

is very unlikely to find contexts in which VOLITIONALITY does not equal AGENCY so I only coded AGENCY. The other two subcomponents were not relevant because there were no proper names in the dataset and the objects in this construction tend to be referential.

Four more variables not part of the Transitivity parameters were added: CASE, PERSON, NUMBER and TENSE. CASE refers to the case of the clitic in the construction and the other three all refer to features of the causative verb (i.e., PERSON is grammatical person of the causative verb, NUMBER refers to whether the causative verb is plural or singular and TENSE refers to the tense of the causative). In addition, two random variables, VERB and COUNTRY, were included. VERB refers to the infinitive verb in each sentence and COUNTRY refers to the variety of Spanish according to the corpus. Due to data sparsity (i.e., very few data points for some levels of a variable), the variables TENSE and PERSON were binarized such that TENSE was coded for *past* vs. *non-past* and PERSON for *3<sup>rd</sup>* vs. *non-3<sup>rd</sup>*.

Once the data were coded, I created a new variable TRANSITIVITY\_SCORE. To calculate the score, each high Transitivity value was given a 1 and each low value was given a 0. For example, for the PARTICIPANTS parameter, *transitive* equals 1 and *intransitive* equals 0. Then the numerical values for all parameters were added up for each sentence and the result was divided by the number of parameters so that the score ranges from 0 to 1; the higher the score, the more transitive the sentence is. Since Individuation is made up of four sub-parameters in the present study, the total score for Individuation was first computed by adding up the four sub-parameters and dividing this result by four. The computation of the scores is illustrated in equations (1) and (2).



**Table 3.** Variable names and values used in the statistical analysis.

Variable Name	Possible Values	Variable name	Possible Values
AFFECTEDNESS	<i>affected/ non-affected</i>	MODE	<i>indicative/ subjunctive</i>
AFFIRMATION	<i>affirmative/ non-affirmative</i>	NUMBER_OBJ	<i>sg/ pl</i>
AGENCY	<i>high/ low</i>	NUMBER_SUBJ	<i>sg/ pl</i>
ANIMATE	<i>animate/ inanimate</i>	PARTICIPANTS	<i>transitive/ intransitive</i>
ASPECT	<i>telic/ atelic</i>	PERSON	<i>3rd/ non-3rd</i>
CASE	<i>accusative/ dative</i>	PUNCTUALITY	<i>punctual/ non-punctual</i>
CONCRETENESS	<i>concrete/ abstract</i>	TENSE	<i>past/ non-past</i>
COUNT	<i>count/mass</i>	TRANSITIVITY_SCORE	<i>continuous between 0-1</i>
KINESIS	<i>state/ non-state</i>		

$$\text{Individuation} = \frac{(\text{ANIMACY} + \text{CONCRETENESS} + \text{NUMBER} + \text{COUNT})}{4}$$

**Equation 1.** Computation of Individuation Score from numerical values of sub-parameters.

$$\text{Transitivity Score} = \frac{(\text{PARTICIPANTS} + \text{KINESIS} + \text{TELICITY} + \dots + \text{INDIVIDUATION})}{9}$$

**Equation 2.** Computation of Transitivity Score from numerical values of the parameters.

## 5.2 Statistical Analysis

The dataset was partitioned into training and testing data. This was done in order to test the prediction performance of the model on new, unseen data after fitting the model. The training dataset contained 75% of the data (3442 sentences) and the testing dataset the remaining 25% (1147 sentences).

The Bayesian models were fit using the Stan modelling language (Carpenter et al. 2017) with the `brms` package (Bürkner 2017). Four sampling chains ran for 3000 iterations each with a warm-up period of 1500 iterations, thereby resulting in a total of 6000 samples for each parameter tuple.

Model-1 consists of a Bayesian mixed-effects logistic regression where each parameter can contribute separately to the model together with the other four variables introduced above. Possible interactions based on the previous literature were tested, namely TELICITY\*ANIMACYOBJ, AGENCYSUBJ\*NUMBERSUBJ, CASE\*AGENCYSUBJ\*ANIMACYOBJ, AGENCYSUBJ\*ANIMACYOBJ, PARTICIPANTS\*CASE, AGENCYSUBJ\*CASE, AFFECTEDNESS\*CASE, ANIMACYOBJ\*CASE, MOOD\*AFFIRMATION and PARTICIPANTS\*KINESIS. I used weakly informative priors for both fixed and random effects. The fixed effects priors were normal priors with mean 0 and standard deviation 2.5 (0,2.5). This loosely constraints the parameter effects to range between -2.5 and 2.5 while allowing for larger values if there is enough evidence for that in the data. For the random effects, I used the default priors, namely a Student's  $t$ -distribution ( $\nu = 3, \mu = 0, \sigma = 2.5$ ). The first step in building the model consisted of fitting a full model with all single parameters and interactions. Then, I calculated the Bayes factors of each parameter in this model. The Bayes factor allows us to calculate the probability of rejecting the null hypothesis of no effect for each parameter given the data. To do this, I calculated a null region such that if an effect fell within this region it was practically equivalent to the null hypothesis (Kruschke 2010). The null region is automatically computed with the `rope_range` function in the `bayestestR` package and it was (-0.18, 0.18). The interpretation of Bayes factors is as follows (Jeffreys 1961):  $BF < 1$  evidence in favour of the null hypothesis (the parameter does not contribute to explaining the outcome),  $BF = 3-10$  there is moderate evidence,  $BF = 10-30$  there is strong evidence,  $BF = 30-100$  there is very strong evidence and  $BF > 100$  extreme evidence. A Bayes factor lower than 1 represents evidence in favour of the null hypothesis. The second step consisted of fitting a model with only those terms whose Bayes factor was larger than 1 and the result was Model-1.

Model-2 is also a Bayesian mixed-effects logistic regression model but it was fit with TRANSITIVITY\_SCORE as the main predictor variable together with the extra variables in Model-

1. The goal of this model is to test whether Transitivity as a scaled measure of the clause can predict the causative predicates. In addition, Model-1 and Model-2 are compared to assess which one of the two ways of operationalizing Transitivity provides the highest predictive power. Because this model has continuous and categorical variables, I followed Gelman et al. (2008) and scaled the continuous variable to have a standard deviation of 0.5. As Gelman et al. (2008) recommend, I used Cauchy priors with centre 0 and scale 2.5 for the coefficients and a Cauchy prior with centre 0 and scale 10 for the intercept. The priors on the random effects were left at the default values as in Model-1. Possible interactions with the three categorical variables in Model-1 were tested but these will not be discussed until the Discussion section because the aim of Model-2 is to test the predictive power of the Transitivity Score on its own.

Model-3 is a random forest with all of the predictor variables. This model allows us to compute the variable importance measure to examine the relative ranking of the variables in distinguishing the two causatives. The random forest was fit with the `ranger` package (Wright and Ziegler 2017). Three separate random forests were fit to ensure the variable importance was stable. Each random forest contained 6001 trees, the `mtry` value was 3 and the random seed for each tree was 124, 125 and 127. The random forest was fit on the entire dataset because model performance assessment was not the goal of this model.

## 6 Results

Convergence of the chains in the Bayesian models was assessed by examining that all  $\hat{R}$  values were lower than 1.1, that the effective sample size was not less than 10% of the total sample size and that the chains had mixed well. All tests showed normal convergence and no convergence problems are reported. A complete table with the diagnostics is in the Appendix as well as a figure with trace plots for each parameter in each model.

## 6.1 Model-1

Model-1 includes COUNT, CONCRETENESS, PERSON, PUNCTUALITY and CASE as single terms and TELICITY\*ANIMACYOBJ, AGENCYSUBJ\*NUMBERSUBJ, MOOD\*AFFIRMATION and PARTICIPANTS\*KINESIS.

I first present the Bayes factor analysis of the predictors in Model-1. Then I will show the posterior intervals of the single terms and finally I will present the interaction terms with the help of marginal effects as interactions are better conveyed visually.<sup>6</sup>

Table 4 shows the Bayes factors (BF) for all the predictors in Model-1. We will focus on the single terms that do not participate in an interaction. These are COUNT, CONCRETENESS, PERSON, PUNCTUALITY and CASE. Of these, PUNCTUALITY shows a moderate or weak effect against the null hypothesis of no effect followed (BF = 1.5) by COUNT, which shows moderate evidence (BF = 5.38). The other three single parameters all show strong evidence of an effect. The interactions all show strong evidence with the exception of TELICITY\*ANIMACYOBJ, which only shows moderate evidence against a null effect (BF = 4.64).

Figure 1 shows the posterior distributions of each single term in Model-1. The posterior distribution credible intervals allow us to see the (un)certainly we have about the real value of the parameter. The wider the credible interval, the less certain we can be. The posterior mean estimate for CASE is -0.64 (CI -0.94, -0.35), which means that *hacer* is less likely to appear with a dative clitic. The evidence for this effect is very strong (BF = 36.23). PUNCTUALITY has a posterior mean estimate of 0.71 (CI 0.10, 1.32) suggesting that *hacer* is more likely with punctual verbs. However, the weak Bayes factor of 1.5 tells us that the evidence for this effect is minimal. The variable PERSON has a posterior mean of -0.71 (CI -1.05, -0.37). This indicates that *hacer* is less likely with non-3<sup>rd</sup> persons and there is very strong evidence for this effect (BF = 53.55). CONCRETENESS and COUNT have the widest credible intervals indicating a higher

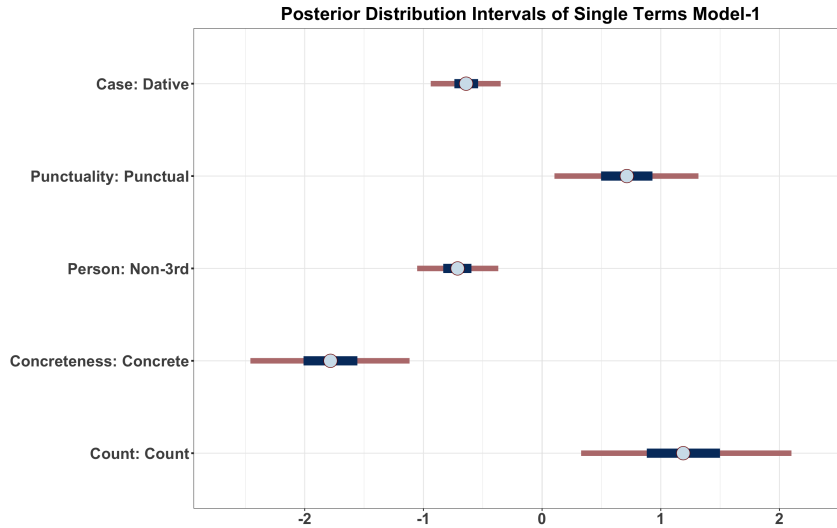
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<sup>6</sup> A complete table with mean posterior coefficient estimates, estimated errors and 95% credible intervals can be found in the Appendix.

level of uncertainty. This is because the dataset does not contain that many examples of abstract and mass nouns. The posterior mean for CONCRETENESS is -1.78 (CI -1.05, -0.37) suggesting that, compared to *dejar*, *hacer* is much less likely with concrete objects. With a Bayes factor of 2061.14, we have extremely strong evidence that this effect is real. COUNT has a posterior estimate of 1.19 (CI 0.33, 2.10), which means that *hacer* is more likely with count nouns. The Bayes factor is 5.38 so we only have moderate evidence for this effect.

Parameter	BF	Parameter	BF
Intercept	0.09	NumberSubj	9.70E+06
Count	5.387	Mood	0.54
Concreteness	2061.138	Affirmation	1014.007
Person	53.551	Participants	0.252
Punctuality	1.493	Kinesis	2.88E+06
Case	36.226	Telicity*AnimacyObj	4.643
Telicity	28.183	AgencySubj*NumberSubj	53.712
AnimacyObj	1.341	Mood*Affirmation	179.418
AgencySubj	8.331	Participants*Kinesis	58.08

**Table 4.** Bayes factors for each parameter in Model-1. A Bayes factor lower than 1 indicates lack of evidence to reject the null hypothesis of no effect.



**Figure 1.** Posterior distributions of single terms in Model-1. The light blue dot represents the mean, the thicker blue line and the thinner red line represent the 50% and the 90% credible interval, respectively.

Interactions are displayed in Figure 2 as marginal effects plots from the `ggeffects` package (Lüdtke 2018), which show the predicted median of all drawn posterior samples. The confidence intervals are Bayesian predictive intervals. To generate the marginal effects all other variables are held at their reference level, which in our case is the lower transitivity value (e.g., PERSON: 3rd, CASE: Dative, etc.).

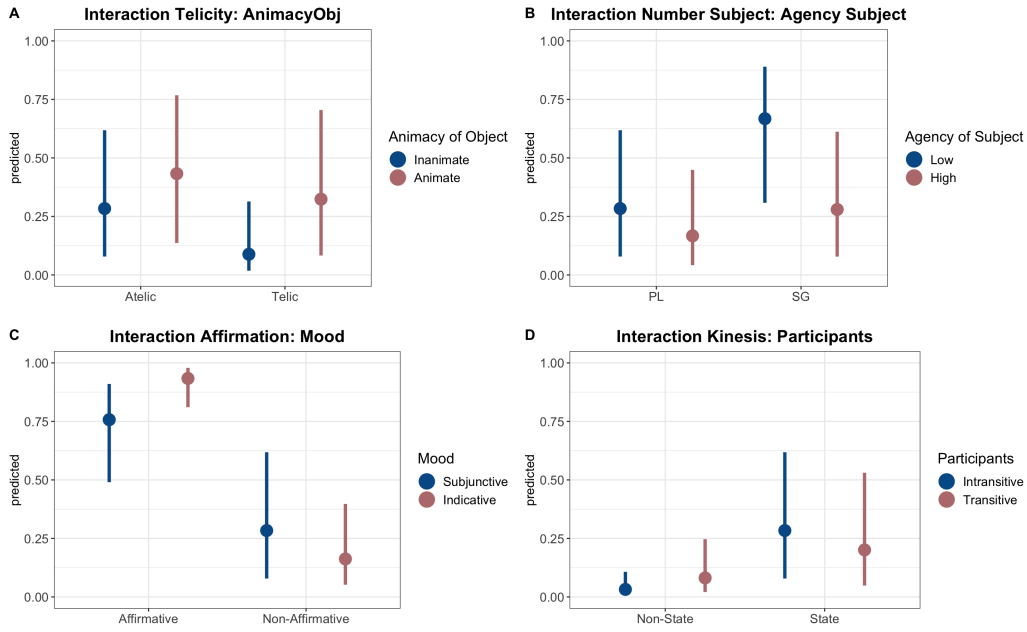
The first interaction in Plot (A) shows the interaction between TELICITY and ANIMACYOBJ. The interaction seems to be driven mostly by the animacy of the object. With both telic and atelic predicates, *hacer* has a lower predicted probability with inanimate objects than with their animate counterparts, so while atelic predicates with animate objects have a predicted probability of 0.43, the probability goes down to 0.28 with inanimates. Likewise, the predicted probability of *hacer* for telic predicates is 0.32 with animate objects but 0.08 with inanimates.

Plot (B) shows the interaction NUMBERSUBJ\*AGENCYSUBJ. With non-agentive subjects the predicted probability for *hacer* is 0.67 with singular subjects and 0.28 with plural subjects. The predicted probability of *hacer* with agentive and plural subjects is 0.17 while that of

agentive singular subjects goes up to 0.28. All in all, we observe that plural agentive subjects offer the least favourable context while non-agentive singular subjects offer the most likely context for *hacer* while all other predictors are held at their reference levels.

The next interaction in Plot (C) is the interaction between AFFIRMATION and MOOD. This interaction shows a sharp contrast between affirmative and non-affirmative clauses. While an affirmative clause in the indicative mood has a very high predicted probability for *hacer* at 0.93, this drops to 0.16 when the clause is negative. In the subjunctive mood, we also see a preference for *hacer* with affirmative clauses at 0.76 but the drop in non-affirmative clauses to 0.28 is less sharp than with indicative clauses though still a relatively large difference between affirmative and non-affirmative clauses.

The interaction between KINESIS and PARTICIPANTS is displayed in Plot (D). With intransitive predicates, the predicted probability for *hacer* sits at 0.28 for states and plummets to 0.03 for non-states. Similarly, with transitive stative predicates the predicted probability is 0.20 but it drops to 0.08 with non-states. All in all, we observe that states favour *hacer* more than non-states.



**Figure 2.** Marginal effects of interaction terms of Model-1. The y-axis shows the posterior predicted probability of *hacer*.

Recall that we are also interested in the predictive power of the model. The confusion matrix showing the model performance on training and new data appears in Table 5. The predictive accuracy of the model is excellent reaching 90% accuracy on the training data and 85% on unseen data. Training data is the data the model was fitted on and unseen or new data refers to data the model has never seen. Using unseen data to test the model's predictions is a reliable way to assess how well the model can predict which causative is most likely to be used in a given context. The fact that the difference between training and testing accuracy is small indicates a very good model fit that is not overfitted.



**Table 5.** Confusion matrix for Model-1. In the shaded diagonal cells are the correct predictions. The non-shaded cells show the incorrect predictions.

Training Data			New Data		
Prediction	Reference		Prediction	Reference	
	<i>Dejar</i>	<i>Hacer</i>		<i>Dejar</i>	<i>Hacer</i>
<i>Dejar</i>	1430	182	<i>Dejar</i>	448	76
<i>Hacer</i>	188	1642	<i>Hacer</i>	91	532
Accuracy: 0.90			Accuracy: 0.85		
95% CI: (0.88, 0.90)			95% CI: (0.83, 0.87)		
Kappa: 0.78			Kappa: 0.71		
F1: 0.89			F1: 0.84		

## 6.2 Model-2

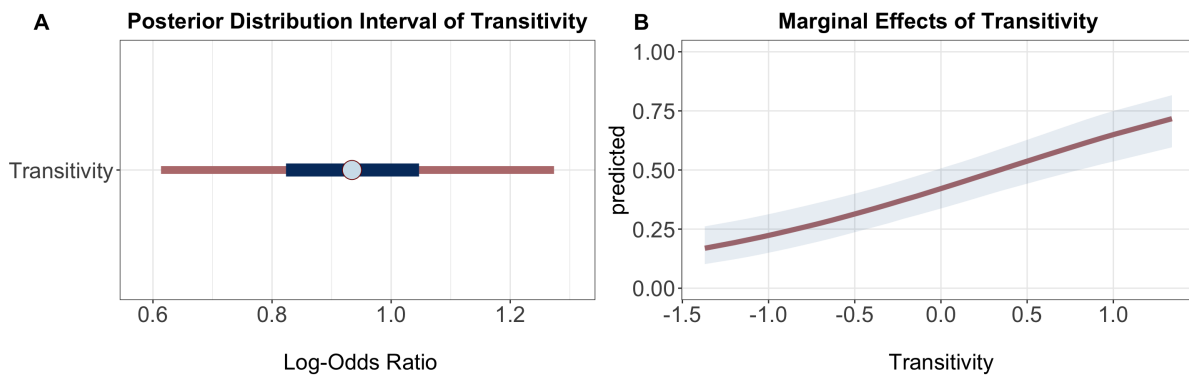
In Model-1 the model contained the Transitivity parameters individually such that each could contribute to the model separately. In Model-2, I test the proposal that Transitivity is a scale in the literal sense. As explained in the Methodology section, Model-2 contains the Transitivity Score as a predictor. The extra variables CASE, PERSON and NUMBERSUBJ that were present in Model-1 were added to Model-2. No interactions are reported in this section because the goal of this model is to see how the Transitivity score compares to the individual parameters and adding an interaction would obscure the results. Therefore, Model-2 comprises the Transitivity Score and the three variables in Model-1, namely CASE, PERSON and NUMBERSUBJ.

In Figure 2, I present the posterior distribution intervals in Plot A and the marginal effects of the Transitivity Score in Plot B.<sup>7</sup> The posterior mean estimate of the Transitivity Score is 0.94 (CI 0.61, 1.29), which means that a Transitivity increase in the score increases the likelihood of *hacer*. In Plot B we see this more clearly; as Transitivity increases along the x-axis so does the predicted probability of *hacer*. With the lowest Transitivity score, that is when all parameters have the low value on the Transitivity scale, the predicted probability of *hacer*

<sup>7</sup> The complete table with the posterior distribution estimates, estimated errors and 95% credible intervals can be found in the Appendix.

is 0.17. On the other end of the scale, when all the parameters have the high Transitivity values, such that the Transitivity Score reaches its maximum possible value, the probability of *hacer* increases to 0.72.

The predictive power of Model-2 is shown in the confusion matrix in Table 6. The model achieves relatively good predictive power with 86% accuracy on the training data and 78.5% on new data. Compared to Model-1, the predictive power of Model-2 is lower. However, this result might be somewhat expected since when all the parameters are collapsed into one single score some information is likely to be lost (e.g., the interactions between the parameters in Model-1 cannot be captured in the score).



**Figure 3.** Plot A: Posterior distribution interval for Transitivity Score in Model-2. Plot B: Marginal effects of the Transitivity Score in Model-2. The y-axis shows the posterior predicted probability of *hacer*. The x-axis shows the scaled values of the Transitivity Score.

**Table 6.** Confusion matrix for Model-2. The shaded diagonal areas show the correct predictions.

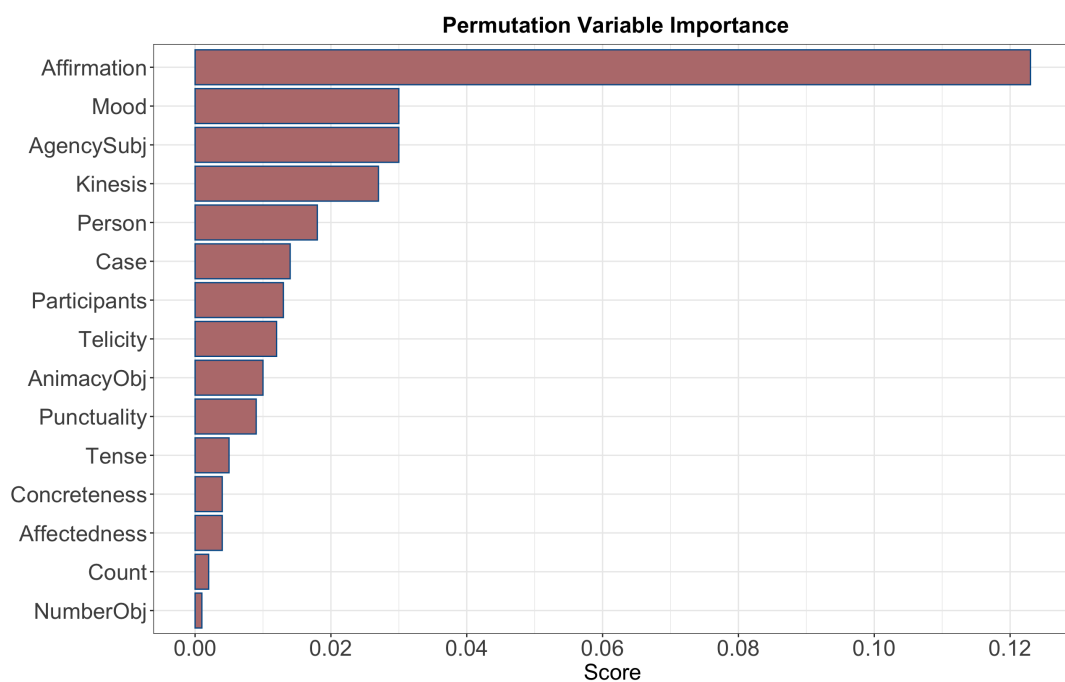
Training Data			New Data		
	Reference			Reference	
Prediction	<i>Dejar</i>	<i>Hacer</i>	Prediction	<i>Dejar</i>	<i>Hacer</i>
<i>Dejar</i>	1386	248	<i>Dejar</i>	411	119
<i>Hacer</i>	232	1576	<i>Hacer</i>	128	489
Accuracy: 0.86			Accuracy: 0.78		
95% CI: (0.85, 0.87)			95% CI: (0.76, 0.80)		
Kappa: 0.72			Kappa: 0.57		
F1: 0.85			F1: 0.77		

### 6.3 Model-3

Recall that the aim of Model-3 is not prediction but a more complete understanding of the relative importance of each of the Transitivity parameters in the distinction between the two causative predicates. We now know which parameters play a role in the characterization of the causatives, but what is the relative importance of each parameter?

Figure 4 shows the variable importance score of all the variables used in the analysis. The most important parameter distinguishing between the two causatives is AFFIRMATION. The difference between it and the next variable is very large suggesting that this is by far the most distinguishing feature between the two predicates. In Model-1 we saw that non-affirmative clauses had an extremely low probability for *hacer* and this is reflected in the variable importance of the random forest. Interestingly, the second most important variable is MOOD, which, as we saw in Model-1, participates in an important interaction with AFFIRMATION. The least important variables appear to be TENSE, CONCRETENESS, AFFECTEDNESS, COUNT and NUMBEROBJ. We saw that the Bayes factor analysis showed that TENSE, AFFECTEDNESS and NUMBEROBJ did not offer enough evidence against the null effect so these three variables are not included in Model-1. However, CONCRETENESS and COUNT were included in Model-1

although their Bayes factors are very different. COUNT had a very moderate Bayes factor of 5.40 while the Bayes factor for CONCRETENESS was very high at 2061.14. We observed, however, that their credible intervals were wider than the rest of the parameters and I noted that this was because there were not many data points for abstract and mass nouns in the sample. The variable importance shows this effect because the lower number of data points causes these variables to have a low predictive power, which is what the variable importance score measures.



**Figure 4.** Permutation variable importance of the random forest model with all the variables considered in the present study. The x-axis indicates the score of the permutation variable importance: the higher the score, the higher the importance.

## 7 Discussion

In general, the analysis shows that the causative predicates can be accurately characterized by the degree of Transitivity of the linguistic context in which they appear. I will now address the research questions, hypotheses and predictions set out in Section 4 and then I will discuss how

the results herein compared to what has been reported in previous studies and I will conclude with possible future avenues of research.

## 7.1 Research Questions and Hypotheses

**RQ 1:** *Can the Transitivity parameters predict which causative will appear in a specific context?*

**RQ 2:** *If the answer to (i) is affirmative, are all parameters relevant?*

**Hypothesis 1:** The causatives *dejar* and *hacer* will be predictable from the Transitivity parameters.

**Hypothesis 2:** The causative *hacer* will be more transitive than *dejar*.

On the one hand, we saw that Model-1 achieves 85% accuracy in prediction of new data, so this indicates that the Transitivity parameters are certainly very important factors in distinguishing the causative predicates and the data supports Hypothesis 1. On the other hand, we also saw that two of the parameters were not relevant, namely AFFECTEDNESS and NUMBEROBJ, the latter being subsumed under INDIVIDUATION. Other parameters like TELICITY and MOOD are only relevant in conjunction with other parameters as the interactions in Model-1 show. Thus, the Transitivity parameters are very good predictors of the causative predicates, but not all individual parameters appear to be relevant. As for Hypothesis 2, even though not all single parameters are on the high Transitivity side for *hacer* in Model-1, *hacer* does show higher levels of Transitivity overall as Model-2 clearly shows, so the results support Hypothesis 2.

**RQ3:** *How strong is the relationship between the Transitivity parameters and the causative constructions?*

In Model-1 we saw that only a subset of the parameters were relevant but the final model predictive performance is still excellent so those parameters that are relevant are relatively strong predictors with 85% accuracy on new data. Moreover, Model-2 also showed that even when all the parameters are considered together in the Transitivity Score, the model achieved

nearly 80% accuracy on new data, suggesting that again Transitivity can predict the two causatives very well. In addition, the variable importance in Model-3 also allowed us to see the relative importance/strength of each parameter. These results provided further support for Model-1 because the parameters with the lowest scores in the variable importance ranking were either the same parameters that were not included in Model-1 or their posterior distribution intervals had a higher degree of uncertainty. All the results point to the conclusion that Transitivity is the overall property that distinguishes the two causative predicates and therefore Transitivity is strongly correlated with the choice of causative.

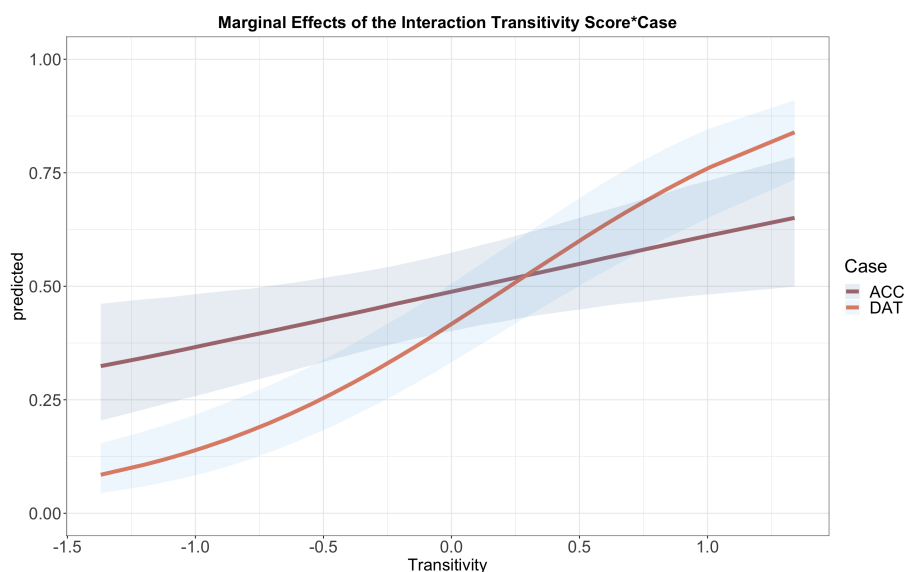
***RQ4:** Do the values of each parameter co-vary in the same direction as predicted by the Transitivity Hypothesis?*

**Hypothesis 3:** The parameters will align in the same direction for each causative.

In Model-1 we saw that this is not the case. The parameters differ in the way they affect the probability of one or the other causative. For example, while the posterior estimate of the interaction between MOOD and AFFIRMATION points to higher Transitivity for *hacer* (2.19, [CI = 1.16, 3.18]) because indicative mood in affirmative clauses increases the probability of this causative, the posterior estimate for CONCRETENESS (-1.78, [CI = -2.46, -1.12]) points to lower Transitivity because concrete objects disfavour *hacer*. Having said that, Model-2 showed that overall it is true that as Transitivity increases there is a clear rise in the probability of *hacer*. Thus, at the parameter level the values seem to diverge from the well-behaved expected direction, but at the global level it seems that these divergences may cancel each other out and the direction towards one end of the Transitivity scale is strong enough for Transitivity to be a good predictor. In short, strictly speaking Hypothesis 3 is not supported by Model-1 and we must entertain the possibility that the Transitivity Hypothesis as originally stated may be too strong.

## 7.2 Model-2 with interactions

As I said in the Results section, in Model-2 I did not include interactions because the goal was to investigate the predictive power of the Transitivity score on its own. However, I did evaluate the interactions of the three categorical parameters with the Transitivity Score and the Bayes factor for one of them, namely TRANSITIVITYSCORE\*CASE, showed very strong evidence in favour of an interaction (BF = 232.64). Based on this result, a new model with the interaction term TRANSITIVITYSCORE\*CASE and PERSON and NUMBERSUBJ as single terms was fit. The results are shown in Figure 5 as marginal effects of the interaction term. The results show a very interesting difference between low and high levels of Transitivity and the case of the clitic. In particular, we can see that with lower levels of transitivity the predicted probability of *hacer* is higher with the accusative clitic while with the highest levels of Transitivity the dative clitic increases the probability of *hacer*. The reason for this result may be explained by the affinity of the dative clitic for human/animate objects. Even though it is perfectly grammatical for the dative clitic to be used with inanimate objects, it appears overwhelmingly much more often with human referents in the causative construction. This is, in fact, in line with Hopper and Thompson's observation that indirect objects tend to be definite and animate and they suggest they should be called Transitive Objects (Hopper and Thompson 1980: 259).



**Figure 5.** Marginal effects of the interaction between Transitivity Score and Case in Model-2. The x-axis represents the scaled Transitivity Score and the y-axis the posterior predicted probability for *hacer*.

## 7.2 Comparison with previous findings

A number of claims and findings from previous work were tested in the full model that gave rise to Model-1. The following are the claims, the predictor variables that were used to test the claim and the work where the claim was proposed.

- a) *Hacer* places selectional restrictions on the causee such that it can only take an accusative object provided the causee is animate (Moore 1996) → ANIMACYOBJ\*CASE
- b) The accusative case has been correlated with higher Transitivity (Ganeshan 2019) → CASE
- c) Intentionality has been attributed to *hacer* but lack of intentionality to *dejar* (Ruiz-Sánchez 2006) → AGENCYSUBJ
- d) The dative clitic is more common than the accusative with both causatives (Engiels 2012). → CASE



e) *Hacer* appears with a dative clitic when an inanimate causer appears with an inanimate causee (Enghels 2012). → AGENCYSUBJ\*ANIMACYOBJ\*CASE

Claim (a) makes reference to the interplay between features of the object and the case of the clitic and I interpreted this as a meaningful interaction between ANIMACYOBJ and CASE such that the model would show evidence that animate objects would appear marked with an accusative clitic with *hacer*. With a Bayes factor of 0.21 no evidence was found in favour of this interaction. Below are two examples (7a-b) out of a total of 341 to illustrate that *hacer* can take an accusative clitic with an inanimate referent.

7. a. Toma      otro      puñado      de      hojas,      las      hace      caer.  
 takes.3S    another    handful    of    leaves    them.FEM   makes.3S   fall.INF  
 ‘He takes another handful of leaves and drops them’  
 (Peru: 240)
- b. El                  evitar      el                  tema no      lo                  hace      desaparecer.  
 the.MASC        avoid.INF   the.MASC    topic not    it.ACC        makes.3S   disappear.INF  
 ‘Avoiding the topic will not make it disappear’  
 (Colombia: 850)

The claim in (b) was tested by looking at the CASE variable. If this claim is true, then we expect that the accusative clitic will favour *hacer* because Model-2 shows that higher levels of Transitivity correlate with *hacer*. However, we saw that when the Transitivity Score interacts with Case, then the predicted probability of *hacer* is higher with the dative clitic at higher levels of Transitivity so the answer to this question is not so straightforward. Overall, we can see that both cases increase the predicted probability of *hacer* as Transitivity increases but the dative clitic seems to be associated with a higher level of Transitivity than the accusative clitic as Figure 5 shows. A more definite answer could perhaps be found by modelling CASE as the dependent variable and TRANSITIVITY SCORE as the predictor. I leave this analysis for future research. However, what these results do highlight is that there may not be a one-to-one mapping between clitic case and Transitivity and whether a particular clitic is associated with

more or less Transitivity is likely to be structure-dependent and not an inherent property of the clitic itself.

In claim (c) I tested AGENCYSUBJ to probe whether agentive subjects would favour *hacer* as was claimed by Ruiz-Sánchez (2006). The mean estimate of the posterior distribution for this variable is -0.67 (CI -1.08, -0.27). But this posterior estimate refers to agentive subjects that are plural because AGENCYSUBJ participates in an interaction with NUMBERSUBJ. The estimate for the interaction is -0.96 (CI -1.47, -0.46), which refers to agentive subjects that are singular. Therefore, agentive subjects disfavour *hacer* so claim (c) is not supported by the data. The data in (8) illustrate the type of non-agentive subjects with *hacer* in the sample. The difference between these results and Ruiz-Sánchez's study is probably due to the fact that the focus of her analysis was on animate subjects and the present study includes all types of subjects.

8. a. hasta que el verdadero amor le haga abrir  
until that the.MASC true love her.DAT make.3S.SUBJ open.INF  
los ojos  
the.PL eyes  
‘Until true love makes her open her eyes’  
(Argentina: 1)
- b. Su inconformidad [...] lo hizo activarse.  
his inconformity him.ACC made.3S activate.INF.REFLEX  
‘His inconformity made him wake up’  
(Nicaragua: 27)
- c. [...] lejos de esas cosas que los hacen dudar [...]  
far from those.FEM things that them.ACC make.3PL doubt  
‘Far from those things that make them hesitate’  
(Dominican Republic: 747)

The claim in (d) says that overall we should find that both causatives appear more often with the dative clitic than the accusative clitic. If this were true, then CASE would not be predictive of either causative because the same case would favour both causatives. As we have already seen this claim is not supported by the data. The posterior estimate for CASE is -0.63

(CI -0.93, -0.34), and the reference level is accusative. This means that the dative clitic disfavours *hacer*. Moreover, the Bayes factor is 36.23 indicating very strong evidence that CASE is an important predictor variable. The difference in the result between the present study and Enghels's is likely due to the fact that Enghels (2012) study is about Peninsular Spanish, whereas I have mentioned above, the dative clitic is used to mark masculine animate direct objects besides all indirect objects. When Peninsular Spanish is removed from the sample, the amount of data containing dative clitics decreases substantially and, as a result, CASE becomes an important predictor such that the accusative clitic appears to favour *hacer*.

Last, the claim in (e) was interpreted as predicting a three-way interaction between AGENCYSUBJ\*ANIMACYOBJ\*CASE, such that non-agentive subjects with inanimate objects in the dative case would favour *hacer*. The mean of the posterior distribution for this interaction is 0.40 (CI -1.17, 2.02), which means agentive subjects with animate objects in the dative case favour *hacer*. However, the Bayes factor for this three-way interaction is 0.32 indicating no evidence of an effect.

In sum, the data in the present study do not support the claims just discussed. Of course, there can be a myriad of explanations for why the results differ. First, the present study focused on American varieties of Spanish whereas most of the studies discussed have focused on Peninsular Spanish or have discussed the construction more generally without mentioning a specific variety. Second, the scope and data type of the studies also differ. For example, Ruiz-Sánchez (2006) is only concerned with animate causers and uses self-constructed examples and Moore (1996) is a theoretically focused investigation that also uses introspective examples. Perhaps, more importantly, none of the studies use statistical analyses of the data so while the generalizations might be true at the level of individual sentences, they may not be generalizable enough to reach statistical significance.

### 7.3 Future research and directions

The results reported in the present study open the door to a more general application of the Transitivity parameters to a broader range of linguistic phenomena. In general, research has tended to focus on a subset of the parameters such as affectedness, agentivity and features of the object such as referentiality or specificity. A promising avenue of research would be to apply the whole set of parameters to see whether a more fine-grained characterization and explanation of the same phenomena can be achieved. To the best of my knowledge, a numerical continuous scale such as the Transitivity Score has not been used in Transitivity studies. This score has the potential to be used as a standard measure against which different linguistic phenomena can be compared systematically.

In this paper, I quantified the parameters as if the relevance of each parameter were equivalent so they all have an equal chance to contribute to the Transitivity Score (either 1 or 0). Another way to operationalize Transitivity as a continuous measure could be to assign different weights to each parameter based, for example, on cross-linguistic evidence that some parameters may be more relevant than others in the Transitivity scale. Another possibility worth exploring would be to assign more informative priors to each parameter in Bayesian models once sufficient information is available from the literature.

## 8. Conclusion

By means of advanced statistical analyses of a relatively large dataset of naturally-occurring sentences, in this paper I have demonstrated that the two Spanish causatives *dejar* and *hacer* can be characterized and accurately predicted by Hopper and Thompson's (1980) Transitivity parameters. We saw that the causatives can be predicted both when Transitivity is operationalized as discrete single parameters as in Model-1 or as a composite continuous measure as in Model-2. Perhaps not surprisingly, better results are obtained when the

parameters are used individually as a variety of interactions can be included in the model with single parameters that cannot be implemented in the composite measure.

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