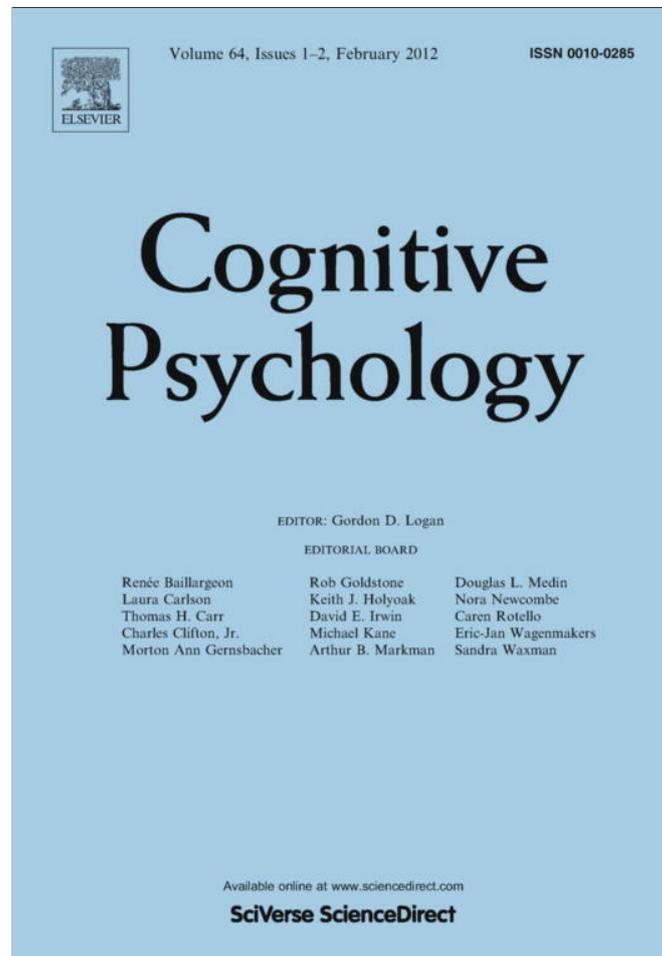


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# Animacy and competition in relative clause production: A cross-linguistic investigation

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## ABSTRACT

This work investigates production preferences in different languages. Specifically, it examines how animacy, competition processes, and language-specific constraints shape speakers' choices of structure. English, Spanish and Serbian speakers were presented with depicted events in which either an animate or inanimate entity was acted upon by an agent. Questions about the affected participant in these events prompted the production of relative clauses identifying these entities (e.g., *the bag the woman is punching*). Results indicated that in English, animacy plays a strong role in determining the choice of passive structures. In contrast, it plays a less prominent role in Spanish and Serbian structure choices, where more active structures were produced to varying degrees. Critically, the semantic similarity between the agent and the patient of the event correlated with the omission of the agent in all languages, indicating that competition resulted in the agent's inhibition. Similarity also correlated with different functional choices in Spanish. The results suggest that similarity-based competition may influence various stages of production planning but its manifestations are constrained by language-specific grammatical options. Implications for models of sentence production and the relationship between production and comprehension are discussed.

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## 1. Introduction

Most thoughts that people express in language can be produced in several different ways, varying in sentence structure, lexical choices, and other dimensions. For example, when asked which book one

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is reading, one may reasonably answer *the book that was recently banned by the Saudi government*, or *the book that the Saudi government recently banned*. A blend of these two, such as *the book that was recently the Saudi government banned*, does not provide a grammatical answer, however. Together, these facts present some of the key challenges in language production—various options exist for a speaker to convey a thought, but a single one of these options must be rapidly and uniquely adopted in order to produce coherent utterances. Research in sentence production seeks to explain how speakers and writers converge on a single produced form over other alternatives, because producers' utterance choices across varying environments should be informative about the underlying production mechanisms.

Production planning, including converging on utterance forms, is thought to be governed by production efficiency (Bock & Levelt, 1994; Ferreira, 1996; Ferreira & Swets, 2002; Smith & Wheeldon, 1999). By uttering more readily produced or *accessible* portions of an utterance early, additional time is gained to plan less accessible components, thus maximizing fluent incremental production (De Smedt & Kempen, 1987; Kempen & Hoenkamp, 1987; Levelt, 1989). Very often, placing some element early in the utterance plan has the effect of constraining the form of the rest of the sentence, so that syntactic structure emerges not from deliberate choices of the production system but as a consequence of accessibility-based entrance of words into the utterance plan (Bock, 1987). Accessibility is understood as the ease with which a word, phrase or concept is retrieved from memory: some elements, by virtue of being short, frequent or conceptually salient, require less retrieval effort and thus tend to be uttered early in the sentence (Bock, 1987; Bock & Irwin, 1980; Bock & Warren, 1985; McDonald, Bock, & Kelly, 1993). Animate nouns in particular have been shown to be more accessible than inanimate nouns, due to their conceptual salience. Animates' heightened accessibility thus influences choices of active vs. passive structures or double object vs. prepositional dative forms (McDonald et al., 1993). English speakers, for example, have a tendency to locate animate concepts in early sentence positions, even when they are not agents: the passive *The boy was hit by the truck* is preferred over the active *The truck hit the boy* (Bock, Loebell, & Morey, 1992; Clark, 1965). This tendency has often been cast in terms of subject function because in English, first-mentioned words are strongly correlated with syntactic subjects, although in other languages, animacy (and other factors) may also influence word order (i.e., early mention) in addition to syntactic function (Branigan, Pickering, & Tanaka, 2008; Prat-Sala & Branigan, 2000; Tanaka, Branigan, McLean, & Pickering, 2011; Yamashita & Chang, 2001).

In contrast to these effects of animacy on the structure of simple sentences, less is known about the role of animacy in the production of more complex structures such as relative clauses (see Gennari & MacDonald, 2009). Relative clauses are thought to function like predicates or modifiers of a head noun, e.g., in *the book that I bought*, the relative clause *that I bought* modifies the noun *book* (Chierchia & McConnell-Ginet, 1990). According to some descriptions based on corpus studies, the discourse function of relative clauses is either to ground the head entity with respect to given information in the discourse or to provide a characterization of it (Fox & Thompson, 1990). Relative clauses are an excellent domain in which to investigate how producers converge on utterance choices, for several reasons. First, unlike main clauses in which passives and actives have different noun orders, the head of the relative clause in English invariably takes the initial position in the structure by virtue of discourse considerations and language-specific constraints (e.g., English is a head-first language, meaning that the head of the relative clause precedes the relative clause). In examples (1)–(4), for instance, the head noun *man/bag* must occur at the start of the clause, and only the subsequent noun–verb order in the relative clause differs in active and passive structures. Thus, factors other than those operating in simple sentences may play a role in relative clause production.

- (1) *Animate Head, Passive*: The man (who's) being punched (by the woman).
- (2) *Animate Head, Active*: The man (who, that) the woman is punching.
- (3) *Inanimate Head, Passive*: The sand bag (that's) being punched by the woman.
- (4) *Inanimate Head, Active*: The sand bag (that) the woman is punching.

Second, both passive and active relative clauses are relatively common in English, and their production frequency has been shown to vary as a function of head-noun animacy (Gennari & MacDonald,

2009; Roland, Dick, & Elman, 2007), thus resulting in an environment in which we can observe both kinds of choices and investigate the factors that, together with animacy, motivate them. Third, relative clauses have played an outsized role in studies of sentence comprehension, as object relative clauses such as *the activist that the Saudi government banned* have been repeatedly shown to be hard to comprehend and recall (Baird & Koslick, 1974; Gennari & MacDonald, 2008; Mak, Vonk, & Schriefers, 2002; Sheldon, 1974; Traxler, Morris, & Seely, 2002). The exact causes for the particular difficulty of object relative clauses are a topic of debate that many see as one of the central issues in contemporary sentence comprehension research. While the current article does not address comprehension, it is worth noting that our own approach to this debate critically invokes patterns of language production in accounts of comprehension behavior. Specifically, our Production Distribution Comprehension (PDC) account suggests that people's comprehension difficulty, including difficulty with relative clauses, is strongly influenced by the distribution of utterances that they have previously heard and read (Gennari & MacDonald, 2009; Wells, Christiansen, Race, Acheson, & MacDonald, 2009). These distributional patterns are in turn shaped by the implicit utterance choices made by the language production system. On this view, an understanding of speakers' choices and the factors that govern them offers the potential for insight not only into production processes but into comprehension behavior as well.

Our goal in this work is to use relative clauses to investigate the factors that shape structural choices in production across three languages that offer different options in the formation of relative clauses. We specifically examine how these language-specific constraints interact with animacy-based accessibility to influence syntactic function assignment, and moreover, whether other mechanisms concurrent with accessibility also play a role in this process. One such mechanism may arise from the presence of conceptually similar nouns in a clause (Ferreira & Firato, 2002; Fukumura, van Gompel, Harley, & Pickering, 2011; Meyer, 1996; Smith & Wheeldon, 1999, 2004). Smith and Wheeldon (2004) showed that in picture descriptions in which two nouns were required, participants took longer to plan their utterances when descriptions included conceptually similar nouns (e.g., *saw* and *axe* in planning *the saw and the axe move together*), compared to conceptually dissimilar nouns (*saw* and *cat*). They suggested that the temporal overlap in accessing the nouns gives rise to interference or competition between these words during phrase planning. Meyer (1996) also showed that the scope of initial planning in structures containing two nouns encompasses the two nouns, although other work also indicated that the scope of planning is not fixed and flexibly changes as a function of task demands (Konopka, 2012; Wagner, Jescheniak, & Schriefers, 2010). Specifically for relative clauses such as *the dog that is next to the kite*, Smith and Wheeldon (1999) showed that activating *kite* before speech onset facilitates initiation times, indicating that some processing of the second noun in the relative clause occurs before speech onset (if only the first noun is planned before speech onset, the pre-activation of the second noun should not have any influence on initiation times). These findings are consistent with Smith and Wheeldon's suggestion that some temporal overlap exists, if only at a conceptual (lemma) level, in the planning of two nouns to be named in sequence, thus leading to semantic interference if conflicting semantic information is present before speech onset – see also picture-word interference effects between distractors and targets (Costa, Alario, & Caramazza, 2005; Glaser & Dünghoff, 1984; Glaser & Glaser, 1989; Schriefers, Meyer, & Levelt, 1990). It is therefore very likely that in object relative clauses such as examples (2) and (4), where the second noun may closely follow the first, utterance planning involves some temporal overlap in the planning of the two nouns and hence potential interference between their meanings or concepts.

Outside the domain of complex phrase production, much research has demonstrated the role of similarity-based competition in many language behaviors, including name production, comprehension and verbal working memory. Production studies investigating the factors that modulate choices of referential expressions (e.g., pronouns vs. definite descriptions) for example suggest that the conceptual similarity between the characters to be described from pictures influences the choice of referential expressions, with similarity resulting in referential choices that indicate decreased accessibility of the character to be named (Arnold & Griffin, 2007; Fukumura et al., 2011; Slevc, 2011). In comprehension studies, models of sentence comprehension inspired by working memory research suggests that similarity-based interference leads to greater processing cost when the target to be retrieved from memory during comprehension syntactically or semantically overlaps with

distractors available in working memory (Gordon, Hendrick, & Johnson, 2001, 2004; Lewis & Vasishth, 2005; Van Dyke, 2007; Van Dyke & Lewis, 2003; Van Dyke & McElree, 2006, 2011).

Taken together, these findings suggest that competition mechanisms may operate in relative clauses either at a conceptual level or at the level of syntactic function/thematic role assignment. Two animate nouns such as *man* and *woman* in (1) and (2), for example, may compete because they are similar and conceptually salient, and both concepts convey typical agent or subject characteristics. Once one concept (lemma) has been selected or its role assigned, the remaining concept or role is inhibited and thus less available for further mention in the structure, compared to situations with two less similar nouns. In English, this competition would result in a passive relative clause structure that allows the speaker to delay mention of the less accessible element until the end of the utterance (in an agent *by*-phrase such as *by the woman*, McDonald et al., 1993). An alternative explanation however is that passive utterances may be favored for reasons independent of competition: speakers who produce a passive such as (1) may do so simply because the head of the main clause, *man*, was more accessible and thus was assigned the subject function in the relative clause, independent of any other sentence elements. Thus an examination of English alone cannot fully address whether competition joins accessibility in governing structure choices because both alternatives result in similar structures.

These considerations led us to investigate the production of relative clause structures as in (1)–(4) using three languages with different sets of structure choices, allowing us to evaluate the contribution of both animacy-based accessibility and similarity-based competition on structural choices. We examined three typologically different languages: English, Spanish and Serbian. These languages belong to different linguistic families (Germanic, Romance and Slavic) and therefore have undergone independent historical developments over many centuries, yielding different grammars, different degrees of morphological complexity, reliance on word order, and other features. As a result, these languages have come to differ systematically in the relative clause structures available to speakers and in the manner in which the words' syntactic functions are marked; several key differences are shown in Table 1. First, in addition to the active and passive forms available for English, Spanish and Serbian speakers can use impersonal active relative clauses, where the agent of the relative clause event is not mentioned. In these impersonal forms, structure choice does not coincide with subject-function: Spanish and Serbian speakers may start their utterance with the more accessible element (e.g. *man*) but need not assign to it the subject function in the relative clause. This suggests that the more accessible element does not necessarily and automatically get assigned a subject function, if the speaker has such impersonal structures available. Thus a major dependent variable in our studies is the extent to which speakers in the three languages choose active object relatives, passive relatives, and (where available) active impersonal forms when using relative clauses to describe animate and inanimate entities.

A second factor that may influence utterance planning is that the three languages have different options to mention or omit the agent of the event in the relative clause. For all three languages, the passive form gives the option of omitting or including the agent phrase, as indicated with parentheses around *by the woman* in all passives in Table 1. Spanish and Serbian also have another route to omitting the agent, in that the active impersonal structure obligatorily omits the agent. In these active structures, the head of the relative clause receives the object function but the relative clause verb does not agree in person and number with any constituent. Instead, it has a third-person plural marker, which is used to indicate an unspecified agent (someone) and the grammatical subject in these structures (*they*) is not pronounced (see below for more details). Because the inclusion or omission of the agent may be diagnostic of competition processes between the head of the relative clause and the agent, in that greater competition may lead to higher rates of agent omissions, a second dependent variable in our studies is the rate of agent omission.

A third relevant cross-linguistic difference is in the degree of case marking in relative clauses. Whereas English has no systematic syntactic function markings (case) on common nouns and relative pronouns, Spanish has optional object marking on relative pronouns occurring with animate heads (expressed by *al* in Table 1). In contrast to both English and Spanish, Serbian obligatorily marks syntactic functions in all its nouns and relative pronouns. This difference in obligatoriness of head-noun marking (via the relative pronoun) before the relative clause can further influence utterance choices, such that the obligatory marking may lead to easier discrimination of the nouns and their syntactic functions in the utterance plan, given that their roles need to be specified overtly early in the utter-

**Table 1**  
Differences in choices of structure and case marking between English, Spanish and Serbian.

Language	Available choices		
	Structure	Case-marking	Examples
English	Active object Passive	–	<i>The man (who/that) the woman is punching</i> <i>The man (who/that is) being punched (by the woman)</i>
Spanish	Active object	Optional for animate heads	<i>El hombre (al) que la mujer está golpeando</i> the man who(m) the woman is hitting 'the man who(m) the woman is punching'
	Active impersonal		<i>El hombre (al) que están golpeando</i> the man who(m) are hitting 'the man being punched'
	Passive		<i>El hombre que está siendo golpeado (por la mujer)</i> 'The man that is being punched (by the woman)'
Serbian	Active object	Obligatory for nouns and relative pronoun	<i>Čovek koga udara žena</i> man-NOM whom is hitting woman-NOM 'the man whom the woman is punching'
	Active impersonal		<i>Čovek koga udaraju</i> man-NOM whom are hitting 'the man being punched'
	Passive		<i>Čovek koji je udaren (od strane žene)</i> man-NOM that-NOM is hit (by the woman-GEN) 'the man who is punched (by the woman)'

*Note:* Parentheses indicate optional material. Non-literal translations are provided in quotes. Both Spanish and Serbian allow some variation in word order in relative clauses; the word order most frequently produced by our experiment participants is shown here.

ance. A comparison of structural preferences across these languages should therefore begin to illuminate how language specific constraints interact with production mechanisms in producing complex structures.

Corpus data allow us to anticipate some structural preferences in English, but we know of no corpus analyses of relative clauses in Spanish and Serbian. Overall, it is reasonable to expect that to the extent that accessibility and/or competition can influence utterance form, the effects will be stronger in linguistic environments in which producers have several viable alternative structures than in situations in which the language is overwhelmingly biased to uttering a single sentence structure. In English, several studies have shown that active object relatives almost exclusively occur with inanimate heads. In contrast, relative clause structures with animate heads tend to be passives, despite the fact that in main clauses, passives are rare (Fox & Thompson, 1990; Gennari & MacDonald, 2008, 2009; Mak et al., 2002; Roland et al., 2007). Thus we expect to replicate the passive preference for animate heads in English, but the extent to which this effect holds in the other languages, and the extent to which passives will be agentless, are unknown. In Spanish, passives with the verb *to be* appear to be infrequent in main clauses, as in English main clauses, but passive-like constructions with various pronominal forms (pronoun *se* and arbitrary plural pronouns) are quite common in main clauses. These structures are similar to the impersonal constructions above, where unspecified agents are not mentioned (Jaeggli, 1986; Takagaki, Zaima, Tsuruga, Moreno-Fernández, & Kawaguchi, 2005). In Serbian, on the other hand, grammatical descriptions and previous studies suggest that passives are very rare, a characteristic shared with other Slavic languages (Kostić, 1986; Mrazović & Vukadinović, 1991; Myachykov & Tomlin, 2008). Thus, while Spanish appears to allow some forms of agent omissions in main clauses and both Serbian and Spanish do not seem to prefer passives in main clauses, it is unclear what preferences would emerge in relative clauses, given that relative clause preferences could be different from those in main clauses as in English.

### 1.1. Implications for theories of sentence production

Disentangling structural preferences across these languages would be significant for theories of sentence production, particularly for hypotheses concerning the interface between message conception and syntactic structure. Within most accounts of this process (e.g., Bock & Levelt, 1994; McDonald

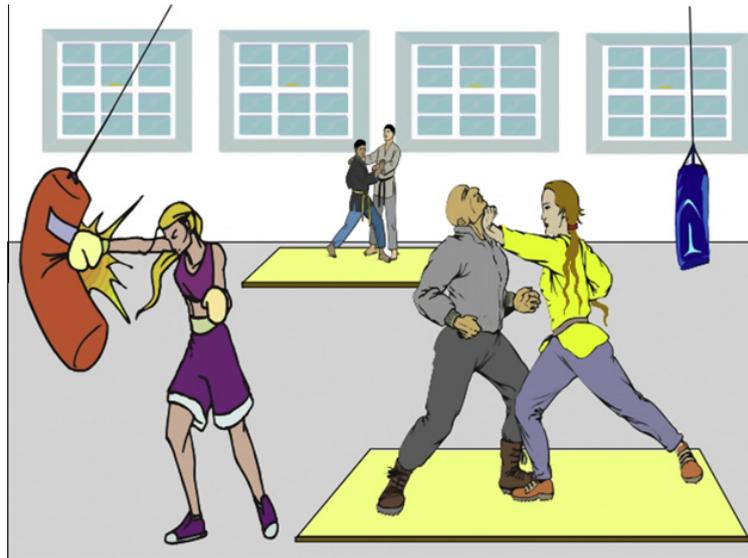
et al., 1993), the conceptual salience of animate entities is thought to govern syntactic choices such as passives vs. actives, because animacy determines the order in which lemmas are retrieved and their functions are assigned. The first-retrieved element (lemma) becomes associated with the most prominent syntactic function, the subject function, during an early stage called functional processing, before any positional information such as word order, case marking or agreement is processed (Bock & Warren, 1985; Bock et al., 1992; Chang, Dell, & Bock, 2006). In this animacy-based retrieval-order view, the surface linear order of a sentence is assembled opportunistically, depending on the order of retrieval: if *boy* is selected earlier than *girl*, the speaker may say *the boy was kicked by the girl*, but if *girl* is selected first, an active structure would emerge – *the girl kicked the boy* (Bock & Levelt, 1994). Since functional processing is taken to be incremental and encapsulated from other processes, lemmas and functions other than those retrieved first need not operate at this early stage, and consequently, should not play any role on subsequent positional processes (until a new lemma is retrieved). This retrieval-order view therefore predicts that the animacy of the first retrieved noun should be solely responsible for structural choices, and in particular, the assignment of subject function, in the present investigation.

Evidence of competition in the formulated structures, however, would challenge the view that retrieval order is the primary determinant of structure choice. If, for example, similarity-based competition influences functional choices because two animate nouns are both strong candidates for subject function, this would suggest that competition operates during functional processing (lemma selection and function assignment). Thus a preference for impersonal or active animate-head structures in Spanish or Serbian as a function of similarity, where the head noun is the object of the relative clause verb, would indicate that competition does not only occurs at message conception or lemma selection level, but also between subject and object functions, leading to the assignment of one or the other function according to the degree of conceptual and functional competition. The existence of competition would not entail that accessibility had no role in planning; rather evidence for competition between elements would challenge the retrieval-order claim that the first-selected element is assigned the most prominent syntactic function (the subject function) independently of other conceptual elements. Similarly, if agent omissions in the structures in Table 1 are modulated by similarity, this would suggest that the nouns entering into a relative clause are not selected or formulated one before the other; instead, they must overlap at some stage for there to be competition leading to the inhibition of one of the nouns. This overlap, even if occurring at the level of lemma selection, would need to percolate down to later stages of processing such as positional stages to affect the agreement features associated with Spanish and Serbian impersonals. Such results would thus challenge a word-by-word accessibility-based retrieval-order view and strict encapsulation. Finally, if case marking in Spanish and Serbian are systematically associated with specific structural choices, this may suggest the need to re-assess the role of case marking in current models, which tend to relegate this linguistic feature to late morphological realization processes, rather than being integral to structural choices. The present studies therefore have the potential to provide significant constraints on the specific shape that the interface between conceptual, functional and positional processes may take.

## 1.2. Overview of the experiments

In all three languages, we showed participants scenes depicting actions with an inanimate theme (e.g., a woman punching a sand bag) or an animate patient (a woman punching a man), plus extra people and objects (see Fig. 1). Picture characters were designed such that responses to questions about the patient or theme of the action would promote an answer containing a relative clause. For example, a question such as *Who is bald?* in the context of Fig. 1 prompts a response similar to those in examples (1) and (2), whereas a question such as *What's orange?* prompts a response like those in examples (3) and (4). The presence of alternative entities in the scene (other people or objects) biased pragmatically informative speakers to provide identifying information unique to the object or person being referred to, which leads to relative clause production (Crain & Steedman, 1985; Hamburger & Crain, 1982; Zukowsky, 2009).

We report five studies investigating structure choice in relative clause production across these languages. In the first three studies, we aim to establish basic production preferences in each language as



**Fig. 1.** Example of picture stimuli in the relative clause elicitation task.

a function of animacy. We first report structure preferences in spoken and written English production (Studies 1a and 1b), to investigate whether these two production modalities affect the distribution of relative clause types, since it is not known whether the absence of time pressures in written production may lead to less temporal overlap, and hence, less competition, between lexical items during planning. Having established few differences between spoken and written production for our picture description task, we report written production studies in Spanish and Serbian (Studies 2 and 3). In the two final studies, we further investigate the role of competition mechanisms in relative clause production by examining whether variations in the degree of similarity between the animate nouns entering into the relative clause affect utterance choices during relative clause formulation.

## 2. Studies 1a and 1b: English relative clause production

These studies aim to determine structure preferences in English relative clause production, and whether they vary in written vs. spoken language. In Study 1a, we report written production and in Study 1b, spoken production. The studies used visual scenes such as that in Fig. 1 and questions about the scene (e.g., *What's orange?*) to elicit relative clause productions. What choices will English speakers prefer in these contexts? It is likely, as suggested by corpus studies, that the animacy of the first noun, stemming from the conceptual saliency of animate entities, determines the noun's syntactic function in the relative clause, so that an animate head noun is the subject of the relative clause verb, resulting in a choice of passive relative, as in (1) above. It is not known however, whether these passives will be full or agentless passives. When the head noun is inanimate, as in (3) and (4), in contrast, the active object relative structure should be a more viable alternative than in the animate-head case, because the inanimate head is less salient and less likely to receive a subject role.

### 2.1. Method

#### 2.1.1. Participants

A total of 82 students at the University of Wisconsin-Madison took part in Studies 1a and 1b (41 students in each study). They were all native speakers of English and were given course credit for their participation.

#### 2.1.2. Materials

Twenty one scenes were created using graphic software and clip art obtained from the web. Each scene contained two animate actors, in different locations in the scene, each performing a similar action such as punching, holding, pushing, etc. In one case the action was performed on an animate

object (a patient), and in the other case with an inanimate object. For example, in Fig. 1, a woman is punching a man, and another woman is punching a bag. Each scene also contained at least one other exemplar of the two action objects, for example an additional man and an additional bag in Fig. 1. These extra scene participants were included to encourage speakers to include relative clause modifiers when answering questions in the experimental task. The full list of scenes is provided in Appendix 1.

Each scene was paired with three questions, one about the animate patient (e.g., *who is bald?*), another about the object theme (*what is orange?*) and another about either of the agents in the scene (e.g., *who is wearing yellow/purple?* for the women in Fig. 1). The first two questions lead to the production of an animate-head or inanimate-head relative clause about the patient or the object theme respectively, thus eliciting a choice between an active object relative and a passive relative. The third question was included to add variability to the produced structures and elicit subject relatives for comparison (e.g., *The woman who's punching a bag.*). There were also 40 filler scenes paired with questions that elicited different kinds of responses (*what are the people doing? what is the boy going to do? etc.*).

Scenes were pre-tested for action name agreement for the verbs used for the depicted actions when the animacy of the object theme varied (i.e., for punching a man or punching a bag in Fig. 1). A questionnaire was constructed and 10 participants were asked to indicate what the relevant characters were doing in the scene (e.g., *what is the woman in yellow doing?*). Only those scenes in which there was over 75% agreement across participants in the two relevant actions were included as stimulus items.

For Study 1b (spoken production), a native English speaker recorded the questions paired with each scene. The speaker was instructed to speak naturally as if asking questions about the pictures to someone. These questions were then played back to participants during the experiment.

### 2.1.3. Design

Scenes and questions were arranged in three lists. Each list presented all fillers and all experimental scenes once. Among the experimental scenes, 7 were paired with animate-patient queries, 7 with inanimate-themes queries, and 7 with animate-agent questions. Each participant thus only saw each experimental scene once and answered only one question about it.

### 2.1.4. Procedure

In Study 1a (written production), the experiment was conducted over a web-based interface using computers in a laboratory room, with an experimenter seated nearby. Participants first read the instructions and saw several examples. Instructions indicated that they would be presented with a picture, and after inspecting it carefully, they had to answer the question appearing below the picture by typing their responses in a text box. To encourage production of relative clauses, participants were told that another participant would later hear their answers while looking at a black and white version of the picture, and that this version of the picture might be reversed from the original. This future participant's task would be to use the current participant's written or spoken answers to identify who or what was being described in the picture. The participants were told that because the picture might be scrambled and not in color, that they should avoid descriptions based on position or color, such as *the man on the right*, or *the man in blue*. The instructions suggested that the safest way to provide a clear description was to describe the action that the characters were engaged in. Because action descriptions generally require a relative clause response of some type, these instructions encouraged relative clause productions without having to mention relative clauses directly in the instructions.

After reading the instructions, participants advanced to a different web page to perform the study. The page contained 61 numbered pictures in random order; the same random order was used in each list. The 14 experimental items were separated by an average of three filler items. Prompt questions (e.g., *What is orange?*) were printed below the picture and participants typed their responses in a box below the question. They were told not to go back to change their answers and move down the page answering the questions in order. Responses were automatically collected.

Study 1b (spoken production) was conducted in the lab via PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants received the same instructions as in Study 1a (with slight wording

changes appropriate for the spoken task) and had a practice session before starting the experiment. During the experiment, each trial started with a fixation cross, followed by the presentation of a picture for 2500 ms. After this time, the question associated with the scene was played over headphones, and participants responded. As soon as participants started speaking, a voice-activated mechanism removed the scene from the screen. This was done to bias subjects to plan as much as possible before uttering their response. A cross then replaced the scene, until the participant was ready for the next trial, at which time, he/she pressed a key to continue. An experimenter was present throughout the procedure and occasionally reminded participants of the instructions. Responses were digitally recorded.

### 2.1.5. Data coding and analysis

Verbal responses in Study 1b were transcribed by research assistants who were blind to the purpose of the study. For the experimental pictures in which an agent was queried, participants routinely produced subject relative clauses; these responses are not discussed further here. For the items querying a patient or theme, responses from both studies were coded by structure: active object relative, passive relative (with and without the *by*-phrase) or other structures. Any response containing the verb *to be* or *get* with a past participle was considered a passive structure irrespective of whether it contained a relative pronoun (*who(m)*, *that*) or an agent *by*-phrase (e.g., *the man being hit*, *the man getting hit by the woman*, *the man who/that is being hit*). Analyses reported below do not include incorrect responses (identification of an entity other than that being intended, e.g., *the woman's hair* in response to *what is orange?* in Fig. 1), irrelevant responses (those that fail to uniquely identify a character in the scene, e.g., *the man* in Fig. 1) or responses with a structure other than the targeted passive or active relative clause (e.g., *the man fighting with the woman*, *the man wearing boots*, in Fig. 1). Some responses of this type are inevitable in a relatively unconstrained production task like this, where we did not directly instruct participants to produce relative clauses.

Participants who had more than 50% irrelevant responses in the experimental items were excluded from the analysis, resulting in the removal of five participants from Study 1a, and two participants from Study 1b. For the 36 remaining participants in Study 1a, excluded responses constituted 23% of the total of 505 responses. When an animate entity was questioned, 19% of responses were excluded, and 27% were excluded for inanimate-heads, leaving 205 and 183 analyzable relative clause responses in each condition respectively. On average, there were 10.75 responses per participant in Study 1a, with around 5 responses per participant in each condition (5.67 vs. 5.08). In Study 1b, with 39 participants, excluded responses constituted 13% of a total of 553 responses, and were evenly distributed across conditions (38 and 33 cases in patient (animate) and theme (inanimate) queries respectively). On average, there were 12 responses per participant in Study 1b, with around six responses per participant in each condition (6.3 vs. 5.97). Thus the rate of analyzable relative clause productions was higher in the spoken task (1b) than in the written task (1a), most likely because the experimenter during the spoken task reminded participants of the instructions discouraging productions of the excluded types if participants produced these responses for practice items.

For each experimental participant in each study, we then computed the proportion of passive relative clauses produced in each animacy condition out of all analyzable responses. Because the proportions are calculated over the total number of relative clause responses, statistics are unlikely to be unduly influenced by different numbers of miscellaneous or incorrect responses in different conditions.

## 2.2. Results

### 2.2.1. Relative clause structure choices

In both Studies 1a and 1b, participants produced more passive relative clauses in the animate-head (patient-query-focus) condition than in the inanimate-head (theme-query-focus) condition. Computed from the total of active and passive structures in each condition, the animate-patient condition yielded 97% passive relative responses in Study 1a and 93% in Study 1b, whereas there were 50% and 44% passives in the inanimate-theme condition in Studies 1a and 1b respectively. We used non-parametric tests to perform statistical comparisons with proportions of passive structures as dependent

measures. For each participant and stimulus item, the proportion of passives was computed from the total number of passive and active object relative clauses in each condition for that item or participant. Fig. 2 shows the average proportion of passives computed across participants. A Wilcoxon Signed Ranks Test comparing these proportions across animacy conditions (animate-head vs. inanimate-head relative clause) indicated that the differences were highly reliable in both studies in by-item and by-participant analyses (Study 1a: by-item  $z = -3.82$ ,  $p < .0001$ , by-participant  $z = -4.56$ ,  $p < .0001$ ; Study 1b: by-item  $z = -4.02$ ,  $p < .0001$ , by-participant  $z = -5.24$ ,  $p < .0001$ ). To see whether there were any differences in passive rate as a function of response modality, we computed Mann–Whitney tests comparing proportions of passives in each condition across studies. These indicated no significant difference in all by-items and by-participant analyses ( $p$ 's  $> .1$ ) except for a marginally significant difference in animate-head passives in the by-item analysis ( $p = .06$ ). These results suggest that the participants' production of active vs. passive relative clauses do not differ as a function of whether they are speaking or typing their responses.

### 2.2.2. Agent omissions in relative clauses

The higher rate of passive usage with animate heads is consistent with the animacy-based retrieval-order account described above, in that the conceptual saliency of animate heads promotes their assignment to subject position in the relative clause, yielding a higher rate of passive utterances for animate heads than for the less salient inanimate themes of the described action. However, the pattern of data in Fig. 2 is also consistent with an alternative account in which competition mechanisms play a role in structure choice, as they appear to in other environments (Smith & Wheeldon, 2004). On this view, two conceptually similar animate nouns (e.g., *man* and *woman* in Fig. 1) generate high competition and therefore are not produced in close proximity (*the man {that} the woman...*) because the selection of one participant in the utterance plan inhibits that of the other, resulting in a passive structure such as *the man that's being punched (by the woman)*, where the nouns are farther apart from each other in the structure or the agent by-phrase is dropped altogether. When the nouns are not conceptually similar (e.g., *bag* and *woman*), little competition occurs and so the nouns can be produced close to each other in the structure. Thus the animacy-based retrieval-order account predicts that passives are a result of promoting animate heads to subject position regardless of their relationship with other conceptual elements, and the similarity-based competition account views the passives as emerging from demotion of the agent phrase via competition with the conceptually similar animate head.

Beyond the passive structure prediction, the competition account makes an additional prediction about the nature of the passive relative clause: Because passives have the option of omitting or

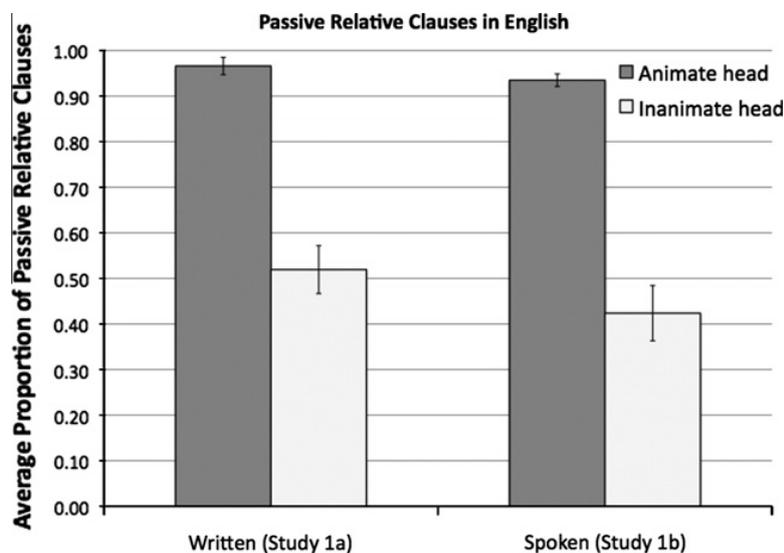


Fig. 2. Average proportion of passive relative clauses as a function of animacy. Error bars indicate standard error.

including the agent *by*-phrase, competition between two conceptually similar animate nouns should result in more agentless passives for animate-head than for inanimate-head relative clauses.

Agentless passives might be thought of as involving a decision to drop the agent *by*-phrase *after* a passive structure (or a structural subject) has been selected during utterance planning. However, if the nouns or concepts entering into the structure overlap during planning before speech onset, rather than having separate word-by-word plans (Konopka, 2012; Wagner et al., 2010), it is likely that reduced relative clauses such as *the man being punched*, which resemble adjectival structures, are planned as such from the outset, rather than as full passive structures that may later undergo *by*-phrase omission. Indeed, agentless passives are considered to alternate with structures containing non-specific uses of pronouns such as *you* or *they*, similar to Spanish impersonals, and constraints on their uses are different from those of full passives (Jaeggli, 1986; Weiner & Labov, 1983). On this view, the choice of agentless structures, as in the choice of Spanish and Serbian impersonals (Table 1), is a choice among other alternatives such as full passives or actives, rather than a choice among passive subtypes. For these reasons, we computed the proportion of agentless passives from the total number of productions in each condition, rather than from the total number of passive productions (which would assume a choice among passive subtypes).

As before, statistics were computed over the proportions obtained for each condition across items or participants. Wilcoxon Signed Ranks tests with the proportion of agentless productions as dependent variable indicated that animate-head structures tended to omit agents more than inanimate head structures in both spoken and written productions, as predicted by the competition account (by-participant analyses:  $z = -4.20$ ,  $p < .0001$ , for written production,  $z = -4.75$ ,  $p < .0001$  for spoken production; by-item analyses:  $-3.14$ ,  $p = .002$  for written production,  $z = -3.84$ ,  $p < .001$  for spoken production). On average across participants, there were 51% and 50% of structures with omitted agents in animate-head structures in written and spoken productions respectively, whereas there were 25% and 18% of structures with omitted agents in inanimate-head structures. Fig. 3 shows the average proportion of agentless structures computed across participants' proportions. This result suggests that under the current assumptions, the competition between conceptually similar animate nouns and the resulting inhibition of the agent of the relative clause event may have contributed to the structure choice in addition to the animacy-based retrieval-order.

Note that if it is assumed that the choice of omitting the agent takes place after the choice of a passive structure, and consequently, we calculate the proportions of agentless structures out of the total number of passives in each condition, a similar pattern emerges, particularly in Study 1b: Out of a total of 217 passives in the animate-head condition, for example, there were 121 agentless passives (=56%),

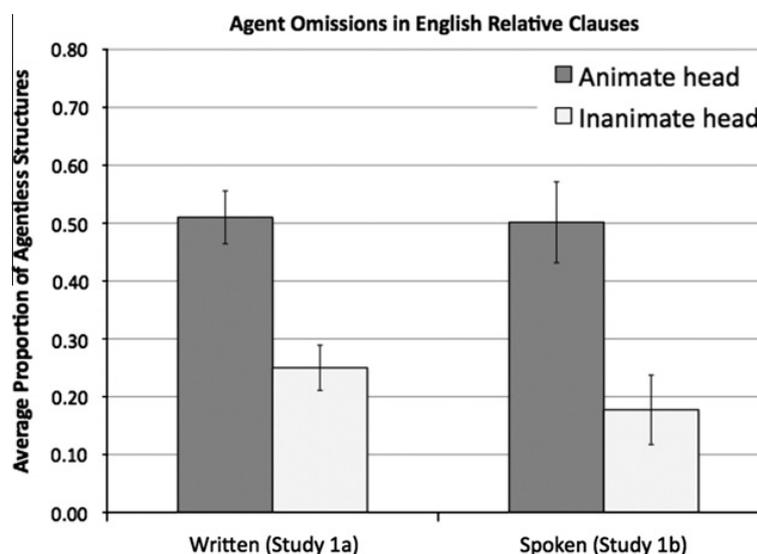


Fig. 3. Average proportion of agentless structures in English relative clause production as a function of animacy. Error bars indicate standard error.

where in the inanimate-head condition, out of a total of 102 passives, 42 were agentless (=41%) (Wilcoxon Signed Ranks Tests by-participant analyses:  $z = -1.40$ ,  $p = .08$  (one-tailed), by-item analysis:  $z = -2.34$ ,  $p = .02$ ). The marginal effect across participants in this analysis is due to the nature of the distributions being compared (proportions of agentless passives for each subject), as several subjects had few full passives in the inanimate-head condition (which biases proportions of agentless-passives towards large numbers in this condition) or no passive structures at all (which are treated as missing values in the analysis). Indeed, results reported later in this article further confirm more agent omissions as a result of competition.

### 2.2.3. Relative pronoun production in relative clauses

It has been suggested that the insertion of an optional *that* or other relative pronouns (*who*, *whom*, *which*) in active object relative clauses alleviates production difficulty because it provides extra time to retrieve difficult upcoming nouns (Ferreira & Dell, 2000; Ferreira & Firato, 2002; Race & MacDonald, 2003), which also tend to be more informative or less expected from context (Jaeger, 2010). If relative pronoun insertion occurs when difficulty is encountered, one might argue that animate-head relative clauses should elicit more relative pronouns than inanimate-head clauses, due to higher competition in this condition. Out of the total of active structures, we indeed found a higher rate of relative pronoun use in animate-head active object relatives than in inanimate-head ones (spoken production: 88% vs. 73%, written production: 83% vs. 77%), although there were overall very few animate-head active cases with which to make any strong conclusions.

In contrast, among passive structures, we found the opposite pattern: fewer relative pronouns in animate-head clauses than inanimate-head ones (spoken: 35% vs. 44%, written: 30% vs. 46%). This pattern was due to less frequent *that*-insertions in animate-head agentless passives compared to inanimate ones (spoken: 24% vs. 42%, written: 24% vs. 52%), whereas full passives do not show any consistent pattern across studies. The lower rate of *that*-insertions in agentless passives is consistent with the idea that relative pronouns function to ameliorate difficult retrieval, because in the agentless passives, there is no noun to retrieve and therefore no need for the relative pronoun (the agent noun is presumably already inhibited at the point of the phonological realization of the relative pronoun). More research is surely needed to understand the use of relative pronouns in full and agentless passive relatives. For this reason, we do not discuss this further.

## 2.3. Discussion

Overall structure preferences indicated that there were minimal differences between spoken and written production, thus suggesting that despite the differences in time pressures inherent in each response modality, speakers' and writers' preferences were very similar for these sentence types. In both spoken and written production, there was a tendency to make animate heads (the query focus) the subject of the relative clause, thus resulting in a passive structure (*the man being punched by the woman*). In contrast, inanimate heads were about equally often produced in a passive or active object relative structure (*the bag being punched by the woman/the bag the woman is punching*). This pattern is consistent with animacy-based retrieval-order mechanisms, in that an animate relative clause head (conceptually and topically salient) would be made the subject of the relative clause verb. Since inanimate heads are less conceptually salient, they are made the subject of the relative clause verb less often, even though they are the query focus. However, the tendency to omit agents with animate heads (particularly when agentless structures are considered as a choice among full passives and active structures) is more difficult to explain within the animacy-based retrieval-order account. Moreover, the results are also not explained by previous suggestions that agents are omitted in passives when they are presupposed in the context (Weiner & Labov, 1983), because in our scenes, agents are equally given in both animate- and inanimate-head conditions. Our results suggest a possible conceptual competition mechanism due to the high similarity of the two animate nouns to be talked about, leading to inhibition of one of them. We will return to these issues in the General Discussion, after we consider relative clause production in Spanish and Serbian, which have more structures available and thus allow a closer examination of the role of competition processes.

### 3. Study 2: Spanish relative clause production

This study explores relative clause structure choices in Spanish. This language arguably affords more alternative relative clause structures than English. In response to a question such as *quién es calvo?* ('who is bald?') in the context of Fig. 1, the alternative responses are as follows:

- (5) Passive: El hombre que está siendo golpeado (por la mujer).  
'The man that is being punched (by the woman)'.
- (6) Active: El hombre (al) que la mujer está golpeando.  
'The man who(m) the woman is punching'.
- (7) Active, impersonal: El hombre (al) que están golpeando.  
'The man (whom) are punching' = 'the man being punched'.

The first two choices are similar to those in English, except that in Spanish, no fixed noun–verb order within the active relative clause in (6) seems to be required (our focus here is on function choices, and so we have only a minimal discussion of word order variations). An important difference with English is that the relative pronoun *que* can be optionally preceded by the preposition *a* plus the article *el*, contracted into *al*, which indicates both object function and animacy: the preposition *a* is used in transitive constructions with animate patients. For example, in the main active sentence *La mujer empuja el escritorio* ('The woman is pushing the desk'), no preposition is used, whereas in *La mujer empuja al hombre* ('The woman is pushing the man'), the preposition is obligatorily used (Bello, 1984). Although the preposition is obligatory in main clauses, it is not obligatory in relative clauses such as (6) or (7) (Abasolo, 1999). Thus, unlike English, Spanish speakers can optionally assign an overtly marked function to an animate head before the relative clause verb is produced. Such intervening marked material may help to discriminate between the functions of the head and the relative clause noun in the structure, given that a choice of marking requires some resolution of the initial competition (if any) between these nouns.

The third alternative afforded to Spanish speakers in (7) also does not appear to be available to English speakers, at least not in relative clauses. In these impersonal structures, the relative clause verb has an active form and is in third person plural, independent of the grammatical number of the head noun (which was always singular in our pictures). This form is often used to refer to non-specific referents, and the third person pronoun is not pronounced. The unpronounced subject (agent) in main clauses typically receives an interpretation as a generic *they* or a non-specific *someone*, as in *llaman a la puerta* ('they are calling at the door') (Bello, 1984; Casielles Suárez, 1996; Jaeggli, 1986; Weiner & Labov, 1983). The fact that these structures are actives and do not have overt subjects provides a unique opportunity to examine the production mechanisms that may affect agent omissions. If competition processes give rise to agent omissions, as argued for English agentless passives, such omissions should be more frequent when competition is strongest, i.e., with animate-head relative clauses, regardless of structure (i.e. with both passives and active impersonals). Alternatively, if animacy-based retrieval order of the head, regardless of its relationship with other conceptual elements, determines syntactic functions in the relative clause, only passive and active preferences should vary as a function of head-noun animacy, with more passives for animate-head relative clauses, as in English.

#### 3.1. Method

##### 3.1.1. Participants

A total of 38 native Spanish speakers were tested. Half of them were students from Puerto Rico and were tested there. All used Spanish as their primary language (at home, with friends and at school), although they also learned English at school. The other 50% were Spanish speakers from Argentina (8), Spain (4) and Chile (7), 14 of whom were graduate students in the US (mean age of arrival = 25). These students reported using Spanish as their primary language all their lives and using English only after arriving in the US for graduate school. All testing was conducted entirely in Spanish with a native

Spanish speaking experimenter. As in Study 1, participants ( $n = 4$ ) with a low number of analyzable responses were excluded.

### 3.1.2. Materials, design and procedures

The materials, design and procedures were similar to those used in English Study 1a. Pre-testing of the scenes with native Spanish speakers indicated that only three of the 21 pictures could not be used in Spanish to elicit passive or active structures because speakers preferred alternative ways of describing the actions. For example, for the English description *the man being touched by the woman* (see picture 21 in Appendix 1), Spanish speakers invariably said, as a few English speakers did, *the man who is talking to the woman*. This picture thus did not allow for a choice of passive or active object relative. These discrepancies across languages meant that 18 of the 21 English pictures from Study 1 were used in this study. The English instructions of Study 1 were translated into Spanish, as were the theme, patient and filler questions. The study was conducted with written questions and responses, as in Study 1a. Participants living in Puerto Rico conducted the study over the web in their home. The remaining students were tested in the lab. Three lists were prepared, each containing six questions about patients, six about object-themes and six about agents, randomly intermixed with filler items. Each participant saw the experimental scenes only once but saw all fillers.

### 3.1.3. Data coding and analysis

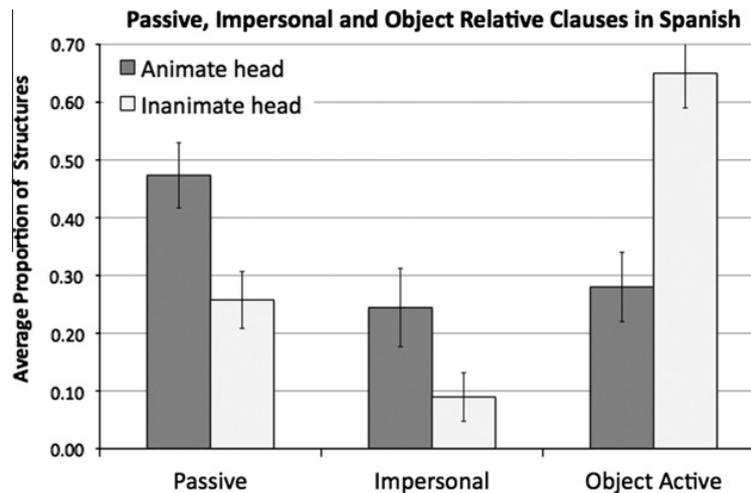
Each response was coded as active object relative, passive relative, impersonal relative clause or other. As in English, we did not analyze responses to filler questions about the agent of the action, incorrect or non-relative clause responses. There were a total of 405 responses of which 26% were excluded, most of which were not relative clauses (e.g., *the man*) or were other types of clauses (e.g., *the man receiving the punch*). From the total of theme and patient query responses, 34% of the total animate-head responses, and 18% of the total inanimate-head responses did not contain relative clauses and were removed, yielding a total of 301 analyzable utterances. On average, there were 8.85 responses per participant, between 3 and 7 in each condition (the means per conditions were 3.82 vs. 5). We computed the proportion of structures from the total of correct relative clause productions in a condition for a given subject or item as in Study 1, and specifically focused on the choices of passive, active object relatives and impersonal structures. Because the calculation of proportions did not include incorrect or miscellaneous responses, proportions are unlikely to be influenced by the different number of miscellaneous responses in each condition. Testing location (US vs. Puerto Rico) yielded no reliable effects and so this factor will not be discussed further.

## 3.2. Results

### 3.2.1. Relative clause structure choices

According to the animacy-based retrieval order hypothesis, the more accessible element (query focus) is assigned the subject position in the relative clause, resulting in more passive structures with animate heads. As in English, Spanish speakers produced more passive structures in the animate-head condition than in the inanimate-head condition (Wilcoxon Signed Ranks Tests: by participants:  $z = -4.22$ ,  $p < .0001$ , by items:  $z = -2.06$ ,  $p = .04$ ). On average, 47% of animate-head responses given to items were passives compared to 26% for inanimate-heads, indicating that for animate heads, there was a tendency to make the head noun the subject of the relative clause structure. Fig. 4 shows the average proportion of structures computed across items. This tendency however was not as prominent as in English: Spanish speakers also chose active structures (active object and impersonal relatives) an average of 53% of the time in this condition, which, taken together, is not significantly different from the percentage of passives (as revealed by a  $\chi^2$  test conducted on the frequency of these structures,  $\chi^2 = .14$ ). Thus, although compared to inanimate-heads, Spanish speakers use more passive structures, they are equally likely to produce an active structure or a passive structure with animate-heads. In inanimate-head structures, in contrast, they largely prefer active structures (74% of inanimate-head structures were actives).

The non-significant difference in the proportion of passive and active structures in animate-heads is somewhat surprising from the animacy-based retrieval order perspective: even though the first



**Fig. 4.** Average proportion of passive, active impersonal and active object relative clauses in Spanish as a function of animacy. Error bars indicate standard error.

element (query focus) is highly accessible, it is equally likely to be assigned the relative clause subject or object function. However, if similarity-based competition processes also play a role, two additional properties of Spanish may have contributed to the above pattern. First, the (optional) marking of the relative pronoun (*al*) for animate-head relatives may have contributed to the discrimination between the two similar entities. In fact, among the animate-head active structures (impersonals and object relatives), 74% of cases contained the *al* object-function marking, suggesting that the use of additional markers in the relative clause structure may be linked to the relatively large preference for active structures, compared to English. Second, the availability of active impersonal structures may have allowed the speakers to produce heads with object function within the relative clause without mentioning the less accessible material (the agent of the event), thus alleviating similarity-based competition. We investigate the rate of agentless structures next.

### 3.2.2. Agent omissions

Computed from the total number of utterances in each condition, 24% of the responses were impersonals in the animate-head condition vs. 9% in the inanimate-head condition (Wilcoxon Signed Ranks Tests: by participants:  $z = -2.33$ ,  $p = .02$ , by items:  $-2.35$ ,  $p = .02$ ). Fig. 4 shows the mean proportion of impersonal structures computed across items. Of the total animate-head structures, an additional 12% were agentless passives, compared to 7% for inanimate-head structures (a non-significant difference). Thus combining the two agentless structures (impersonal plus agentless passives), 36% of the total structures in the animate-head condition were agentless, compared to 16% in the inanimate-head condition (Wilcoxon Signed Ranks test by-items:  $z = -3.05$ ,  $p = .002$ , by-participants:  $-2.33$ ,  $p = .02$ ). Thus, as in English, there is a greater tendency to omit the agent in the animate-head condition compared to the inanimate-head condition, consistent with the similarity-based competition account.

### 3.2.3. Word order choices

As noted above, in Spanish active object relative clauses there is no fixed subject-verb order. Because our focus here is on structure choice, we only briefly report word order variations in active relatives: 50% of inanimate-head active object relatives had subject-verb order (e.g., *La bolsa que la mujer está golpeando* 'The bag that the woman is punching') and 50% had verb-subject order (*La bolsa que está golpeando la mujer* 'The bag that the woman is punching'), suggesting no preference for either subject-verb or verb-subject order in this utterance form. In contrast, 79% of animate-head active object relatives had subject-verb order. From a similarity-based competition perspective, this may seem puzzling, as the relative clause noun competing with the head noun should not be readily available for mention after the head noun, as in *the man whom the woman is punching*. However, active object rel-

atives with subject-verb order represent only 26 out of 130 relatives produced in the animate-head condition and thus they are clearly not a preferred choice among the available alternatives in this conditions (impersonals and passives). Moreover, 65% of these active relatives had an object-marked relative pronoun, which, as suggested above, may help to discriminate the functions of the nouns within the relative clause. More importantly, 81% of these cases were produced with items in which the two animate entities taking part in the event were not very similar, as in cases of dogs interacting with people (a person being bitten/licked by a dog) or adults interacting with young children (a baby being carried/lifted by a person). In these cases, the competition between the nouns is less strong, as suggested by the similarity-based analysis presented in Study 4. It is therefore likely that these few active object structures with subject-verb word order emerge because there is less pressure on speakers to produce a passive or impersonal in order to omit or demote the competing noun, given the potential discriminating role of the marked relative pronoun and the lower conceptual similarity of the nouns in these cases.

### 3.3. Discussion

The Spanish results indicate that, as in English, there is a stronger tendency to assign subject function to animate-head nouns, compared to inanimate-heads, resulting in more passive structures, although overall there is a similar preference to produce passives or actives with animate-head relative clauses. This is consistent with the animacy-based retrieval order account of structure choice in which the most prominent animate noun is made the subject of the relative clause more often with animate-heads than inanimate-heads. However, this tendency is also consistent with the similarity-based competition view in that the agent *by*-phrase is demoted to the end of the structure when two conceptually similar nouns must be planned nearly simultaneously. Nevertheless, Spanish also displays about the same proportion of active structures in the animate-head condition (impersonal constructions and active object relatives), most of which had an object-marked relative pronoun indicating the head noun function. This may have helped discriminate between the functions of the two animate items resulting in a higher proportion of actives compared to English. Importantly, impersonal constructions are produced more often in the animate-head condition than the inanimate-head condition, suggesting that the bias to omit the agent of the structure is stronger when two similar nouns are to be produced. This suggests that similarity-based competition processes influence structure choices in Spanish relative clauses, leading to the inhibition of one of the competing entities. These structural choices are not only linked to subject function assignment but also to object function, rather than simply converging on subject function as in English. Taken together, these results imply that language-specific structure choices and function markings interact with animacy-based accessibility and similarity-based competition to shape relative clause structure choices. Because function markings intervening between the head and the relative clause noun make them functionally more distinguishable, competition resolution may be facilitated in Spanish active structures as much as it is in passives. Function marking may also promote the mapping of animate head nouns onto object rather than subject function, resulting in impersonal and active object relatives. We will return to these issues in the general discussion, after we explore further the effects of case marking and availability of structural choices in Serbian, a language with obligatory case markings on all nouns and pronouns.

## 4. Study 3: Relative clause production in Serbian

In this study, we explored structure choices in Serbian, which is typologically different from both English and Spanish. In Serbian, case marking dominates production choices. Whereas Spanish only optionally marks the animate object of a relative clause structure and English does not mark case (aside from pronouns), Serbian obligatorily marks the case of all nouns and the relative pronoun. Some examples are shown in (8–10), all of which are relative clause descriptions of the man in the foreground of Fig. 1.

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(8) Passive:	Čovek koji je udaren/se udara (od strane žene)/udaren čovek man-NOM that-NOM is hit/'se' hits (by the woman-GEN)/hit man-NOM 'The man who is being punched (by the woman)'/the punched man'
(9) Active:	Čovek koga udara žena man-NOM that-ACC hit woman-NOM 'The man whom the woman is punching'
(10) Active, impersonal:	Čovek koga udaraju man-NOM that-ACC hit-3rd person plural 'The man whom are punching' = 'the man being punched'

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Whereas Serbian actives are very similar in structure to Spanish ones (including possible flexible word orders), Serbian passives in (8) have two forms: one directly analogous to the English and Spanish passive ('to be' + verb marked for passive), and one with an impersonal particle 'se' and an active tense-marked verb form agreeing with the subject in number. In both forms the relative pronoun is marked for nominative case. In addition, Serbian passives may take a reduced form in which the past participle precedes the noun such as *the punched man* meaning *the man being punched*. Interestingly, Serbian does not favor passive structures in general (Kostić, 1986; Mrazović & Vukadinović, 1991), like many other Slavic languages (Myachykov & Tomlin, 2008). These features make Serbian an interesting language to investigate, as the preferred structure for animate-head relative clauses may not be passives. If so, the animacy-based retrieval order account would need to be further qualified: if conceptually salient animate entities, which are easier to retrieve from memory, are not made the subject of the relative clause, what then determines the assignment of a syntactic function to the head noun? We have suggested that for the case of Spanish, the presence of case marking may help the planning of active (impersonal and object relative) structures, which constituted about half of the cases in animate-head relative clauses, in contrast to the virtual absence of animate-head active structures in English. Given that case marking is systematic and obligatory in Serbian and that passives are infrequent in this language, case marking may play a prominent role in Serbian production by mitigating competition and promoting the assignment of object function, rather than subject function as in passives, to the head noun.

#### 4.1. Experimental procedures

##### 4.1.1. Participants

Forty monolingual native Serbian speakers, who were students at the University of Belgrade (20 participants) or University of Novi Sad (20 participants), Serbia, participated in this study for a course credit. Five participants were excluded from further analyses because they provided none or very few experimental analyzable responses, similar to the excluded participants in English and Spanish.

##### 4.1.2. Materials and procedure

Materials and procedures were similar to the studies above. Materials were pre-tested for verb preferences as above, to guarantee that the same verb was used to describe actions with animate and inanimate themes. As in Spanish, some pictures of the original English set were excluded because Serbian speakers provided alternative ways of describing the actions. This resulted in a final set of 14 pictures. Because of the smaller number of picture items in the Serbian study and in order to keep the number of experimental items per participant similar to the English and Spanish study, queries eliciting subject relative clauses were excluded. Thus each picture was paired with two queries, one focusing on the animate patient and the other on the object theme, resulting in two item lists. Each list had 14 experimental items (7 per condition), and 42 fillers. The procedure was otherwise the same as in the Spanish study and Study 1a in English. All participants were tested in a laboratory setting individually or in small groups. Two pictures were excluded from the final analyses due to a low number of analyzable responses.

#### 4.1.3. Data coding and analyses

Each response was coded as passive, active object relative, active impersonal, or other. As in the previous studies, there were responses that were not relative clauses (25% of the total) and they were evenly distributed across animate-head and inanimate-head structures (49 and 57 cases respectively). These responses were excluded from further analyses, yielding a total of 314 analyzable responses. Similar to the studies in English and Spanish, on average there were 8.97 responses per participant, with around four responses per participant in each condition (4.6 with animate heads vs. 4.4 with inanimate heads). Due to the small overall number of passive responses all passive structures were collapsed together (passive clauses e.g., *čovjek koji je udaren/se udara* – man-NOM that-NOM is hit, and reduced phrases e.g., *udaren čovek* – hit-MASC.SG. man-MASC.SG.).

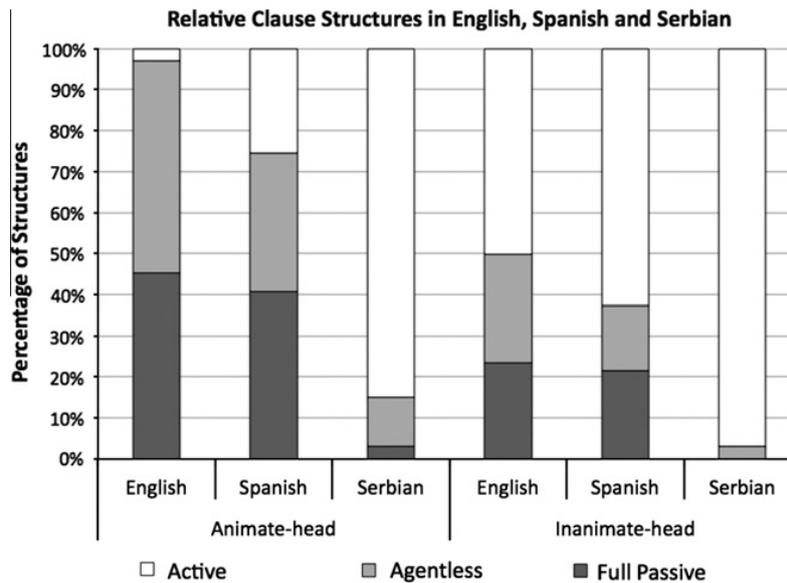
#### 4.2. Results and discussion

Serbian participants overwhelmingly preferred to produce active relative clause structures in both animate- and inanimate-head conditions. On average across participants, of the total of active and passive relative clauses produced in the animate head condition, only 12% were passives. Although small, this proportion was larger than that in the inanimate-head condition (with 7% of passives) (Wilcoxon Signed Ranks Test by-subjects:  $z = -1.65$ ,  $p = .05$ ; by-items:  $z = -1.54$ ,  $p = .06$ , both one-tailed). The majority of passive structures were agentless in both conditions (see Table 2). Serbian speakers also produced a small number of active impersonals, all of which were with animate heads (Table 2). As in Spanish, the proportion of agentless constructions (passives and active impersonals) with animate heads was significantly larger than with inanimate heads (on average across participants, 12% and 4%, respectively; Wilcoxon Signed Ranks Test by-subjects:  $z = -2.4$ ,  $p < .01$ , by-items:  $z = -1.36$ ,  $p = .09$ , both one-tailed). The total percentages of Serbian relative clauses are shown in Fig. 5, along with English and Spanish results for easy comparison. Serbian speakers thus produced active structures with animate-heads far more than in Spanish or English. As a result, they did not omit or demote agents as much as English and Spanish speakers did in using passives and impersonal actives, though the direction of the effect was the same as in the other two languages. These results suggest that the effects of animacy and similarity are similar in character but much weaker in biasing speakers towards these structures. In conjunction with this pattern, note that the Serbian participants tended to produce agent-final active structures independent of condition, as in *Čovek koga udara žena* ‘man-NOM that-ACC hit woman-NOM’ (meaning “the man that the woman hit”), despite the general SVO preference in Serbian main clauses (Slobin & Bever, 1982): 64% of active structures with animate-heads, and the same proportion with inanimate-heads were agent-final, with no significant difference between these distributions (Wilcoxon Signed Ranks Test by-subjects:  $z = -.31$ , n.s.; by-items:  $z = -1.34$ , n.s.). It is thus possible that the general preference for agent-final structures in this task may obviate the agent demotion that was observed in Spanish and English, since the active object relative with agent-final word order already provides speakers with a suitable structure. Final-agent structures together with obligatory pronominal case marking may thus conspire to ease or resolve competition between semantically similar nouns to the extent that other structures, particularly infrequent passive ones, need not be invoked. We will return to these issues in the general discussion.

**Table 2**

Counts of responses for animate and inanimate head relative clauses in Serbian.

	Animate head	Inanimate head
Active object relatives	138	147
Active impersonals	4	0
Full passives	4	1
Agentless passives	15	5
Miscellaneous	49	57



**Fig. 5.** Percentage of active, full passive and agentless structures in English, Spanish and Serbian. In English, agentless structures are agentless passives. In Spanish, these structures include agentless passives and active impersonals.

## 5. Comparison across languages

The differences between the three languages investigated are striking (see Fig. 5). Although speakers of all three languages show a tendency to produce more passive structures with animate-head relative clauses than inanimate-head ones, this tendency is reduced in Spanish, with the production of more active structures (impersonals and object relatives) than in English. The use of passive is even more reduced in Serbian, where the majority of productions are active object relatives, with a minimal effect of animacy. These differences are confirmed by Kruskal–Wallis tests, which allow non-parametric comparisons across independent distributions. Comparing the proportions of passives across languages shows a main effect of language both for animate and inanimate-head conditions in by-items and by-subjects analyses (animate by item:  $\chi^2 = 41.43$ ,  $p < .0001$ ; inanimate by item:  $\chi^2 = 22.45$ ,  $p < .0001$ ; animate by participants:  $\chi^2 = 63.54$ ,  $p < .0001$ , inanimate by participants:  $\chi^2 = 35.82$ ,  $p < .0001$ ). Fig. 5 also shows the reversed preference for active structures across language. Although English speakers used more active relative clauses in the inanimate-head condition than in animate-head relative clauses, these actives are less frequent than in Spanish and Serbian. These observations suggest that the alternatives available to the speakers in each language are quite different.

These results also point to language specific constraints in relative clause production and variability in the role of animacy-based head noun accessibility across languages: in English, animate heads almost always yield passive structures, whereas in Spanish and Serbian, animacy-based accessibility plays a more limited role in structure choice, as actives are also possible or preferred. Animacy-based accessibility is therefore not necessarily equated with subject function in languages other than English, suggesting that ease of retrieval due to conceptual salience is less influential in determining subject function for Serbian and Spanish speakers, consistent with previous reports for Spanish main clauses (Branigan et al., 2008; Prat-Sala & Branigan, 2000). Nonetheless, to varying degrees, all three languages tend to demote the agent to final position or tend to omit the agent of animate-head relative clauses. These tendencies are manifested in both full and agentless passives in English and Spanish, as well as in Spanish active impersonals, and Serbian agentless passives and active impersonals. This suggests the possibility that all speakers experience competition but resolve it in different ways, an issue investigated in more detail in the next study.

A possible concern with cross-linguistic comparisons of this sort is that differences across languages can be due to differences in the sets of items used in each language rather than to the languages themselves. Recall that fewer pictures were used in Serbian than in English and Spanish

because responses in these languages did not yield relative clauses for some pictures. To address this potential issue, we conducted non-parametric tests across languages using only those pictures ( $N = 12$ ) that were common across all studies. A Friedman test conducted across the same item set revealed highly significant differences between the languages' distributions of passive proportions, both in animate-head responses ( $\chi^2 = 22.16$ ,  $p < .0001$ ) and inanimate-head ones ( $\chi^2 = 16.04$ ,  $p < .0001$ ). The average proportions of passives calculated over the common item set replicate the same pattern of results previously reported (English animate: .97, English inanimate: .46; Spanish animate: .45, Spanish inanimate: .25; Serbian animate: .12, Serbian inanimate: .7). It is thus unlikely that the different item sets were responsible for the structure preferences observed.

Another possible concern with cross-linguistic comparisons is that English language experience, particularly in the Spanish group, may have influenced responses, as English was the second language of many participants (Serbian speakers were monolingual). While this possibility cannot be completely ruled out, the fact that Spanish speakers produced more actives than English speakers and differentially produced impersonal structures depending on animacy, which are not available in English, suggests that the influence of English was negligible. Moreover, the differences across groups are highly reliable for the same set of pictures. Comparing only English and Spanish across the set of common items between these two languages ( $N = 18$ ) revealed highly significant cross-linguistic differences in the distribution of utterances ( $z = -3.73$ ,  $p < .0001$ ), with the proportion of passives (out of total productions in each condition) being higher in English than Spanish for both animate-head clauses (.98 vs. .47) and inanimate-head clauses (.51 vs. .25). If English knowledge was responsible for the Spanish speakers' choices, no difference should be observed. Therefore, it is unlikely that Spanish speakers' proficiency in English is responsible for the results we have reported. We consider other issues in cross-cultural research in the next two studies, where we evaluate the role of similarity-based competition in structural choices in these languages.

## 6. Study 4: Exploring conceptual similarity

The evidence so far indicates that the role of animacy-based accessibility in function assignment (or structure choice) within relative clause structures is limited in languages other than English. Moreover, the agentless structures discussed above are difficult to explain in terms of animacy-based retrieval order: the easier retrieval of animate nouns does not seem related to the omission of the remaining animate noun (the agent), unless some relation or interaction between the nouns is assumed, as a competition account would suggest. Here we attempt to further explore the extent to which similarity-based competition may be related to production choices. Because concepts may compete with each other due to their conceptual similarity (e.g., Costa et al., 2005; Glaser & Dünghoff, 1984; Glaser & Glaser, 1989; Schriefers et al., 1990; Smith & Wheeldon, 2004), we examined more directly whether similarity plays a role in the production preferences we have discussed. To this end, we collected similarity ratings between event participants in the relative clauses and then correlated these ratings to the choices of structure and agent omissions already observed.

We focused our analyses only on animate entities because animate and inanimate entities clearly differ in their conceptual similarity, and therefore, any role of similarity can be confounded with animacy. Recall that in our stimulus materials, the animate entities being talked about were children, adults or animals. This variability could yield variability in the similarity among the pictured entities: two adults of the same sex, for example, are likely to be more conceptually similar than a child and a dog, even though they are all animate. We thus examined whether animate entities that are perceived as more similar were associated with more agentless passives and impersonal structures in Spanish, and more agentless passives in English. (Serbian was not included because there were very few utterances of the type that would allow agent drop (passives and impersonals), yielding too few observations to conduct the correlation.) A positive correlation between conceptual similarity and the rate of agentless structures would suggest that similarity-based competition processes may lead to such structures, due to more similarity between the animate nouns to be produced with the relative clause.

## 6.1. Method

### 6.1.1. Similarity ratings

A total of 24 native English-speaking students at the University of Wisconsin filled out a similarity-rating questionnaire for course credit. The questionnaire contained the pictures used in the experiments above, including all fillers. Each picture had two objects highlighted by red squares around them. Participants were instructed to indicate in a scale of 1–7 how similar the two highlighted objects or entities were (1 = not similar at all, 7 = very similar). They were specifically instructed not to focus on visual similarity alone (e.g., in color and shape), but also take into account the actions and events in which the objects and people took part and the functions they performed. Examples were provided in which for instance an umbrella and a pair of sunglasses were considered similar, because although they vary in shape, they perform similar functions in the scene (protecting from the weather). There were an equal number of inanimate and animate pairs in the questionnaire. The inanimate pairs served as fillers. Two lists were constructed with different item orders. A given scene (e.g., the punching scene of Fig. 1) appeared once in each list and each list asked for the similarity of different entity pairs (animates or inanimates).

## 6.2. Results

### 6.2.1. Similarity ratings

The mean similarity ratings for the 21 animate pairs ranged from 2.5 (the two children in the pool splashing scene—see Appendix 1) to 5.85 (the dog and man in the beach scene), suggesting that there was a fairly wide range of similarity among the animate participants in our pictures. The overall mean rating was 4.95 and the standard deviation was .99.

### 6.2.2. Correlations

To evaluate whether noun similarity is related to agent mention in production, we correlated these similarity ratings with the proportions of structures in English and Spanish on an item-by-item basis (i.e., for each event described in the animate-head condition). For English, we correlated the proportion of animate-head agentless passives (out of the total of passive structures<sup>1</sup>) with the similarity rating provided for the entities entering into the relative clause. In both spoken and written production we found significant correlations: the higher the similarity rating between the animate entities interacting in the picture, the larger the proportion of agentless passives that were used to describe this event in the relative clause (for spoken production:  $r = .72$ ,  $p = .002$ ; for written production:  $r = .56$ ,  $p = .009$ ). For Spanish, we correlated both the proportion of impersonal structures and the combination of both impersonal and agentless passives (computed from the total of structures for each item in the animate condition). In both cases, there was a significant correlation ( $r = .49$ ,  $p = .04$ ;  $r = .57$ ,  $p = .02$ ). Example correlations for English and Spanish are shown in Fig. 6. A further step-wise regression with proportion of agentless structures as dependent measure and similarity and language (English, Spanish) as independent variables indicated that language does not explain any significant variance over and above that explained by similarity ratings ( $r^2$  change: .04; significance of change: .12). This suggests that the influence of similarity is comparable in both languages.

## 6.3. Discussion

These results indicate a clear relationship in English and Spanish between the similarity of the two animate concepts entering into the relative clause and agent omissions, whether via agentless passives or impersonal structures. When two highly similar animate participants are mapped into a relative clause structure (e.g., man and woman in *the man being punched by the woman*), the second agent noun tends to be omitted. This indicates that competition between similar entities may come into play

<sup>1</sup> There were very few actives in the English animate-head condition, therefore, the proportion of agentless passives calculated out of the total number of passives is virtually the same to that calculated out of the total number of productions in each item, yielding almost identical results.

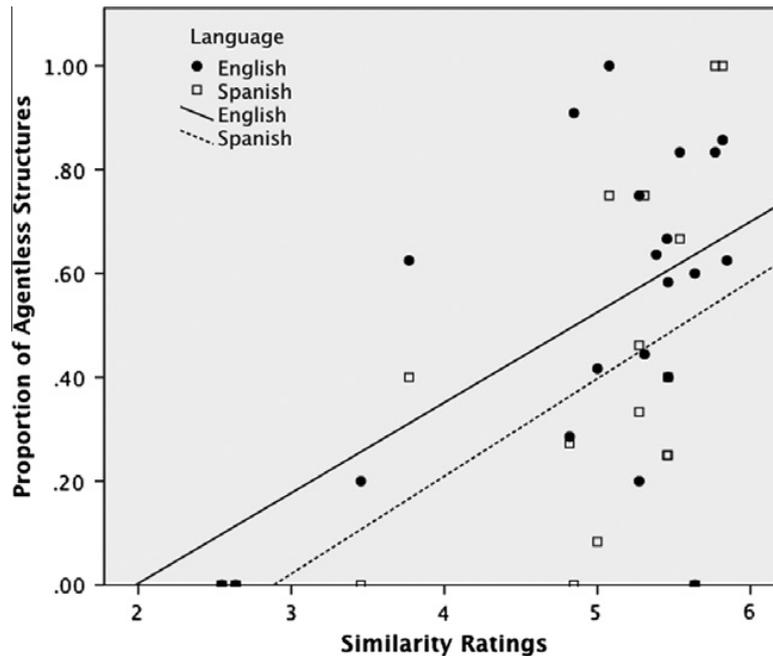


Fig. 6. Correlations between proportions of agentless structures and similarity ratings in both English and Spanish.

to bias agent omissions in English passives and both agent omissions and choices of impersonal structures in Spanish. Critically, the choice of Spanish impersonals, with object function for the head noun and third-person plural verb marking, varies as a function similarity, indicating that the effect of similarity percolates down to functional assignment and morphological markings. Thus, whereas in English the choice of passive vs. active may be interpreted as solely determined by the head noun animacy, the analyses above suggest that similarity-based competition between entities also influences functional and positional choices.

The results also suggest that whatever cultural and linguistic differences might exist between English and Spanish speakers, they are unlikely to influence the relationship between structure choices and conceptual similarity we have revealed here. Note that cultural differences might lead to different interpretations of the situations depicted in the pictures and thus may potentially affect speakers' productions. Indeed, at least one of the pictures excluded from the Spanish set could be interpreted as manifesting such differences, perhaps due to different social norms (the woman touching vs. talking to the man, see Study 2). Although such differences are inevitable in cross-cultural research, the fact that conceptual similarity displays an equivalent influence in both languages suggests that this factor is robust across any variation in culture and likely reflects the effects of language-independent competition mechanisms during production planning.

## 7. Study 5: Manipulating conceptual similarity in English and Spanish

The findings from Study 4 suggest a relationship between the similarity of the two animate concepts entering into the relative clause and agent omissions. However, this study simply correlated similarity with production preferences in a post hoc fashion and the type of conceptual information distinguishing between animate entities pertained to several dimensions or features (e.g., the differences between animals and people or babies and adults encompass several characteristics rather than a single conceptual dimension). Moreover, the effects were observed in a single set of pictures, where it is possible that certain features beyond agent-patient similarity might have contributed to agent omission. To confirm the similarity finding from Study 4 and further investigate whether competition is modulated by smaller differences between animate entities, the present study used new pictures to explicitly manipulate semantic similarity in English (Study 5a) and Spanish (Study 5b) within a well-defined and restricted semantic domain. We specifically focused our manipulation on profession

concepts such as *doctor*, *pilot*, *plumber* as they provide information that can distinguish between different individuals.

Using a similar elicitation technique as in Studies 1–3, we developed clip art scenes in which the actions described within the relative clauses were about highly similar animate individuals (e.g., *the builder that is being slapped by the miner*) or about less similar individuals (e.g., *the builder that is being slapped by the astronaut*). While we term these conditions high-similarity vs. low-similarity, respectively, the pictured entities had many similar features even in the low-similarity condition, in that the scene participants were adults of generally similar ages and often the same gender. We predicted that the rate of agent omission should again correlate with the perceived similarity between the entities: the more similar the characters, the more the agent omissions.

## 7.1. Method

### 7.1.1. Participants

A total of 128 native British English speakers, students at the University of York, took part in Study 5a. For the Spanish study (Study 5b), a total of 45 native Spanish speakers were recruited from the student population at the University of York, the University of Barcelona, Spain and several South American universities. Twelve participants were from Spain, and the remaining participants were from South America (9 from Mexico, 6 from Argentina, 7 from Chile, 8 from Colombia). 17 participants were monolingual Spanish speakers and the remaining 28 participants reported that Spanish was their native and primary language but that they knew English fairly well through schooling. 22 participants studied postgraduate courses in the UK and therefore used English in university lectures and activities. Before arriving in the UK, these speakers used Spanish all their lives at home, with friends and at school.

### 7.1.2. Materials

Sixteen pairs of scenes were created using graphic software and clip art databases. The characters in the scenes were arranged so that in one version of the scene, the two individuals to be talked about were of high similarity, whereas in the other they were of lower similarity. Each scene contained 3 individuals, two of whom – an agent and a patient – were participating in an event, and the third was almost identical to the patient of the event, which encouraged speakers to use relative clause modifiers when answering questions about the patient of the event. An example of high and low similarity scenes for one item is provided in Fig. 7. In this example, the miner and the builder are highly similar, whereas the builder and the astronaut are of lower similarity (note that in American English, *builder* may not be a common description, but it is in British English, as shown below). The full list of scenes is provided in Appendix 2. The scenes were paired with a question about the patient of the action depicted (e.g., *who is wearing an orange shirt?*). There were also 33 filler scenes paired with questions that elicited responses about the actions performed by various characters (*what is the man in red doing? what is the boy going to do? etc.*).

### 7.1.3. Pre-testing of materials

A large set of scene participants was pre-tested for name agreement so as to find stimuli with good name agreement in both languages, thus reducing variability and naming difficulty during the main production task. A questionnaire presenting the characters in isolation (outside the experimental scenes) was constructed. Thirteen British English speakers and 10 Spanish speakers who did not participate in the main experiment were asked to enter the name of the character in a text box. Only characters for which the same name was used by 60% or more of the speakers of both languages were used in the stimuli.

### 7.1.4. Similarity ratings

The characters were also submitted to a similarity rating task such as that described in Study 4. In this task, 24 English participants were presented with pairs of pictures with people in them, and were asked to indicate in a scale of 1–7, how similar were the people in the pictures (1 = not similar at all, 7 = very similar). Examples were provided indicating that a detective and a gladiator were not very



Fig. 7. Example of picture stimuli in Study 5.

similar both in respect of their physical appearance as well as the roles they perform, whereas a satyr and an elf were somewhat more similar. Pairs of characters for which the similarity rating was either high or low were then used to create the experimental scenes. In the final set of stimuli, high-similarity pairs had a mean similarity rating of 5.63, whereas low-similarity pairs had a mean rating of 1.82, a reliable difference ( $t(15) = 22.46, p < .0001$ ). These pairs were then used as the patients and agents of the actions to be talked about in the main experiment.

The stimuli resulting from these pre-tests contained high- or low-similarity character pairs performing the same action in nine items (e.g., carry, pull, stab, kiss, push, kick, slap). In the remaining seven items, the actions were not the same due to plausibility constraints (e.g., not all characters could carry other people) but the scenes were designed in such a way that except for one item, whenever an action occurred in the high-similarity condition, it also occurred in the low-similarity condition, albeit in a different item. This aimed to control for the possibility that action verbs have biases towards omitting agents when occurring in passives.

#### 7.1.5. Design

Scenes and questions were arranged in two lists. Each list presented all fillers and one member of the experimental scene pairs (either the high- or low-similarity scenes for each item), but requested equal number of answers for high-similarity and low-similarity cases. Each participant thus only saw one member of the scene-pairs but answered questions for eight high-similarity and eight low-similarity pairs. Experimental items and fillers were randomly intermixed with the constraint that experimental items did not occur consecutively. The same order of trials was used in both lists and there was on average two filler pictures between experimental trails.

#### 7.1.6. Procedure

The experiment was conducted using a web-based interface (participants filled in the questions in their own place and time). The questionnaire first presented the instructions and several examples. Instructions were similar to those in the previous studies except that we also encouraged participants to use the profession names to refer to characters rather than more generic terms such as *man* or *woman*. After reading the instructions, participants moved onto a different web page to perform the questionnaire. The page contained 49 numbered pictures in random order, using the same display and response format as in the previous studies. Prompt questions (e.g., *who is wearing blue?*) were printed below the picture and participants typed their responses in a box below the question. They were told not to go back to change their answers and move down the page answering the questions in order. Responses were automatically collected. The English and Spanish versions of the questionnaire were the same in all respects except for the language they were written in.

### 7.1.7. Data coding and analysis

Responses from the two studies were coded by structure: active object relative, passive relative (with and without the agent *by*-phrase), impersonal constructions (in Spanish only), or other structures. As in previous studies, incorrect responses (identification of an entity other than that being intended), irrelevant responses (those that fail to uniquely identify a character in the scene) or responses with a structure other than the targeted passive or active relative clause were excluded from the analyses. Responses with several subordinate clauses were also excluded from the analyses (e.g., *the bride that's being kissed by the princess who is holding a red rose*), as we are interested in structures in which the agent is not itself modified, i.e., it does not have greater conceptual and phrasal weight than the head noun.

Participants who had more than 60% excluded responses or large differences across conditions in proportions of excluded responses (more than 50% difference) were removed from the dataset. This was done to guarantee that the proportion of excluded responses was roughly equal across conditions. This resulted in the removal of six participants from the English data, and three participants from the Spanish data. In the English data, excluded responses constituted 17% of the total of 1938 responses. In the high-similarity condition, 18% of the total responses were excluded, whereas in the low-similarity condition, 15% of the total responses were excluded. On average, there were 6.47 analyzable responses per participant in the high-similarity condition, and 6.71 analyzable responses per participant in the low-similarity condition. In the Spanish data, there were 20% of excluded responses, out of total of 798 responses. Of the total responses in the high-similarity condition, 27% were excluded, whereas of the total responses in the low-similarity condition, 22% were excluded. On average, there were 5.72 analyzable responses per participant in the high-similarity condition, and 6.02 analyzable responses per participant in the low-similarity condition. For each experimental participant in each study, we then computed the proportion of agentless passive relative clauses produced in each condition out of all passive responses.

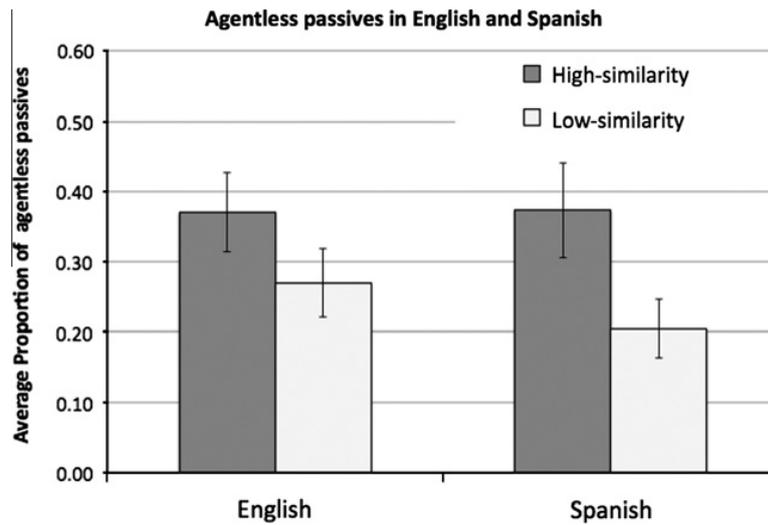
## 7.2. Results

### 7.2.1. Agent omissions

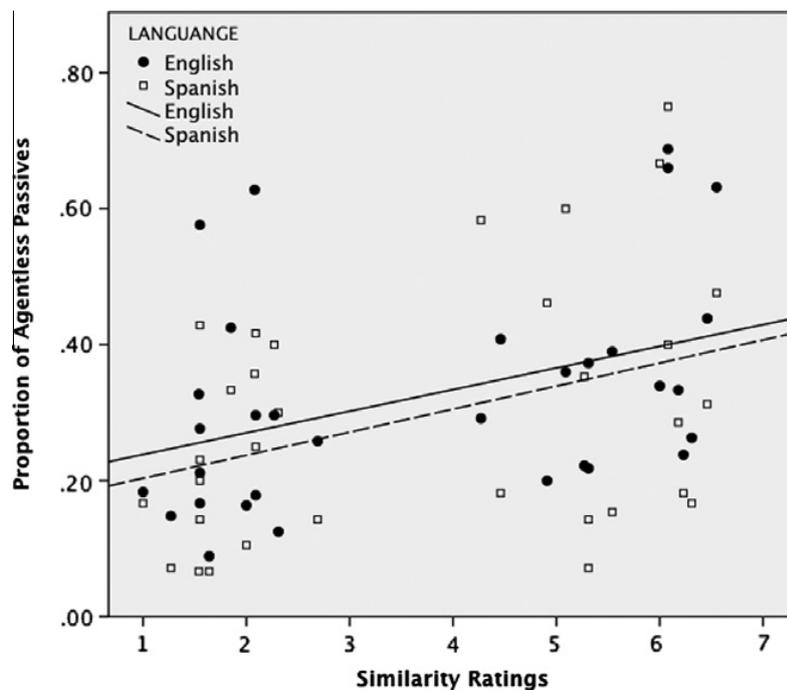
In both English and Spanish, participants tended to omit the agent of the structure more in the high-similarity condition than the low-similarity condition, consistent with the expectation that competition between similar individuals may lead to omission of the agent, due to having inhibited it during planning. In English, of the total of passive relative clauses produced in each condition, 38% were agentless passives in the high-similarity condition, compared with 27% in the low-similarity condition. In Spanish, the percentage of agentless passives (computed out of all passives) was 37% in the high-similarity condition vs. 21% in the low-similarity condition. These results are shown in Fig. 8. A Wilcoxon Signed Ranks test across participants with the proportion of agentless passives produced as dependent measure revealed a significant difference (English:  $z = -4.62$ ,  $p < .0001$ ; Spanish:  $z = -3.37$ ,  $p = .001$ ). To evaluate these effects across items and test the prediction that similarity biases agent omissions, we regressed the similarity ratings with the proportion of agentless passives produced for each item in both English and Spanish. In both languages, there was a significant correlation between similarity ratings and the proportion of agentless passives (English:  $r = .395$ ,  $p = .03$ ; Spanish:  $r = .373$ ,  $p = .04$ ). These correlations are shown in Fig. 9. Finally, in Spanish, there was also a tendency to produce more active structures (both object active relatives and impersonals) in the low-similarity condition than in the high-similarity condition (18% vs. 13% out of all structures produced), although this effect was only significant by participants ( $z = -1.89$ ,  $p = .03$ , one-tailed). This may suggest that the highly similar entities used in this study press Spanish speakers towards passives more than in Study 2, with actives and impersonals only emerging in the low-similarity condition.

## 7.3. Discussion

The results of this study clearly indicate a tendency to omit the agents in passive relative clauses both in English and Spanish when the two animate nouns entering into the structure are highly similar. Given that similarity was explicitly manipulated and incorporated different and better matched



**Fig. 8.** Proportion of agentless structures in English and Spanish in Study 5 as a function of high and low similarity between the animate entities.



**Fig. 9.** Correlations in English and Spanish between similarity ratings in Study 5 and proportion of agentless passives produced.

items and pictures from those in previous studies, these results offer strong support for a role for competition during utterance planning. Interestingly, Spanish speakers were overall less inclined to use active structures than in the previous study, although there was a tendency to produce more of them in the low-similarity condition. This might be due to the fact that although the relevant animate entities differed in their professions and in a few cases, their magical character (e.g., vampire and footballer vs. referee and footballer), they were similar in many other respects or semantic dimensions. In most cases, the two relevant characters were potential actors in the event, i.e., the astronaut could slap the builder or vice versa, and the characters were typically adults of the same gender. This contrasts with our previous studies in which the less similar entities were adults, babies or animals (crabs, dogs), who clearly can play different roles in events (only dogs are likely to bite or lick). Thus, despite

their differences in professions, the animate entities in this study were highly similar and even in the 'low-similarity' condition still entered into competition, leading to more Spanish passives, because the semantic distance between the characters here is smaller than that in previous studies.

## 8. General discussion

This work has examined factors that shape structure choice in relative clause production in a Germanic language (English), a Romance language (Spanish), and a Slavic language (Serbian), which vary widely in the degree of case marking and availability of structures to convey messages with relative clauses. Our aim in conducting this cross-linguistic investigation was to examine whether animacy-based accessibility had consistent effects on structure choices across languages and whether a second factor, similarity-based competition between patients and agents, also contributed to utterance form. This work has yielded several important findings. First, despite substantial cross-linguistic differences in the three languages studied, production choices in all three languages were affected by head noun animacy, a testament to the central role of this conceptual factor on utterance structure. Second, the results showed that the strength of the animacy effect was not universal but varied across the three languages, being extremely robust in English, moderate in Spanish, and weak (though statistically reliable) in Serbian, where speakers strongly prefer active object relatives in our studies, in contrast to the other two languages. Third, beyond its effects on active vs. passive choices, head noun animacy also affected the expression of the agent phrase: all three languages (although only marginally in Serbian passives, which were sparse) showed a preference for omitting agents in the animate-head condition relative to the inanimate-head condition, albeit using different structures (impersonals or agentless passives). Fourth, this agent-omission tendency was shown to be related not simply to head-animacy per se but also to the similarity between the animate entities being talked about, as evidenced by correlations between similarity ratings and proportion of agentless structures both in English and Spanish. A summary of results is provided in Table 3.

### 8.1. Animacy, competition and cross-linguistic differences

The pattern of results reported above is consistent with previous findings in main clauses showing accessibility influences derived from animacy, in that animate heads are often made the subject of the structure, resulting in more passives (Bock & Warren, 1985; McDonald et al., 1993). However, the preference for passive structures in animate-head relatives could instead or in addition be described as a tendency to demote the agent to final structural positions, consistent with the idea that there may be an initial competition between the two animate nouns being planned (e.g., the man and the woman in Fig. 1 and examples (1) and (2)). This interpretation fits well with the fact that most Serbian actives already prefer agent final word order, thus aiding competition resolution. Critically, the tendency to omit agents in all languages cannot be easily explained by the saliency of animate head nouns being promoted to the subject position. Instead, the influence of similarity suggests that competition between conceptually similar animate entities results in the inhibition

**Table 3**

Summary of results in English, Spanish and Serbian.

Language	Effects of noun properties	
	Head animacy	Agent–patient similarity
English	Large effect on passive rate Effect on agent omissions	Agent omission rate (agentless passives) increases with similarity
Spanish	Moderate effect on passive rate Effect on agent omissions	Agent omission rate (agentless passives and impersonals) increases with similarity
Serbian	Small effect on passive rate Small effect on agent omissions	N/A N/A

of the element *not* selected for initial mention. Thus, when producing *the man being punched* in Fig. 1, the competition between *man* and *woman* and the initial selection of *man* is accompanied by the inhibition of *woman*, resulting in its omission from the utterance. This competition is manifested even within a single semantic domain, for example when animate entities only differ in one semantic dimension such as their profession (e.g., *astronaut* and *builder* vs. *miner* and *builder*), suggesting that the influence of competition is graded and varies as a function of semantic similarity of the currently activated concepts, rather than as a function of categorical distinctions such as animacy. This competition may be particularly strong in relative clauses because the animate entities talked about are not only highly accessible and likely agents but also planned in close temporal proximity, as one noun is part of a modifying phrase for the other. In main clauses, however, the temporal proximity in planning a subject and object phrase may not be as close, although this remains to be investigated. A summary of the results accounted for by animacy-based retrieval order and similarity-based competition is provided in Table 4.

Our results also indicate that the competition processes are constrained by alternative structures available to the speakers in different languages. In addition to the impersonal option being unavailable in English, a key difference relevant to competition may be the availability of function marking. In Spanish and particularly Serbian where it is obligatory, marking the head-noun function with respect to the relative clause verb in the relative pronoun may help resolve the competition between the animate nouns by further discriminating their semantic/syntactic roles in the utterance plan and aiding the memory maintenance of the nouns and their event roles to be talked about. Marked pronouns are planned relatively early in the structure and are thought to provide extra time to formulate the relative clause noun in active object relatives, as suggested for uses of English *that* (Ferreira, 2003; Ferreira & Dell, 2000; Race & MacDonald, 2003). In planning *the man-NOM who-ACC the woman-NOM is punching* in Serbian, for example, the selection of *man* and its case may be closely followed by the selection of the appropriate case for the relative pronoun, which indicates the object function of this noun within the relative clause. We hypothesize that this explicit case marking in the relative pronoun clearly marks who is doing what to whom early in the structure and further distinguishes the nouns' syntactic functions, essentially reducing or ending competition between them in the process of mapping the message into a linear order (see more on this below). This relatively low competition, plus the word order freedom to place the agent noun at the end of the utterance, permits the formation of an active structure. Such language-specific processes may explain why there are more active structures, including impersonals, in Spanish and Serbian, compared to English. A summary of the proposed relationship between competition and language specific resources is given in Table 5. Clearly these hypotheses, including the potentially complex relationships between a language's various structure options and word order options, merit additional research.

**Table 4**

Summary of results as explained by animacy-based accessibility alone vs. competition.

Language	Results	Explained by	
		Animacy-based accessibility of head	Similarity-based competition between head and relative clause noun
English	Effect on passive rate	Yes	Yes
	Effect on agent omissions	No	Yes
	Correlation of agent omissions and similarity	No	Yes
Spanish	Effect on passive rate	Yes	Yes
	Effect on agent omissions and impersonals	No	Yes
	Correlation of agent omissions and impersonals with similarity	No	Yes
Serbian	Effect on passive rate	Yes	Yes
	Effect on agent omissions	No	Yes

## 8.2. Implications for models of sentence production

The language-specific preferences in our studies suggest a more nuanced role for accessibility and retrieval order in accounts of structure choice. Whereas prior research (e.g., Bock & Levelt, 1994) did not claim that accessibility was the only determinant of word order and structure choice, it has not always been clear in this work what other forces also influence structure. The present cross-linguistic studies show that the link between noun animacy and structure choice in relative clauses is not as straightforward as initially suggested by English data, and they offer many possible additional influences on structure choice, including the availability of alternative constructions, interference from semantically similar items, the availability of case marking in the language, the flexibility of the word order, and the overall bias in a language against a particular structure (such as passive). We have just begun to investigate only a few of these factors, and it is reasonable to expect that production studies in other languages beyond English, Spanish, and Serbian will be needed to clarify the role of these factors, identify other potential factors, and characterize interactions between them. Nonetheless, the major results we have so far—stronger effects for accessibility in English than in Spanish and Serbian, a relationship between semantic similarity and agent-drop structures, and clear effects of language-specific biases—do permit us to suggest some implications for accounts of sentence-level utterance planning. The next section points out some challenges to traditional accounts brought about by our data and offers some necessarily speculative suggestions for how to accommodate our results in accounts of grammatical encoding. To foreshadow our conclusions, we suggest that our results argue for a more interactive production architecture at the sentence-planning level, similar to more interactive approaches that have been advocated for phonological encoding in the production literature (Dell, Chang, & Griffin, 1999, 2001; Dell & O'Seaghdha, 1992, 1994; Dell, Oppenheim, & Kittredge, 2008).

One feature of our results that challenges traditional accessibility and retrieval order assumptions is the influence of similarity on utterance forms, as already mentioned (see Table 4). This influence suggests that similar nouns or concepts taking part in competition must overlap at some stage of planning. Note that in English, it might be possible to argue along the lines of traditional accounts that animacy affects syntactic role assignments, yielding active/passive choices, and that only later in the structure (perhaps in a different phrasal planning stage), competition between the already produced and the to be produced animate nouns influences agent omissions. However, this possibility would need to explain why and how there can be competition between an already formulated noun and another one yet to be formulated (a possibility inconsistent with word-by-word incremental accounts). More importantly, this putative distinction between an early stage for structure choice and a potentially later choice about agent omission is more difficult to reconcile with languages such as Spanish and Serbian in which the agent phrase need not be at the end of a passive utterance – final agent actives are also possible – and which have an option of the active impersonal construction with unpro-

**Table 5**

Summary of proposed relationship between competition and language-specific resources.

Language	Available structures and resources	Competition is manifested in	Resources aiding competition
English	Full passives, agentless passives, actives	Agent phrase demotion (full passives) Agent phrase omission (agentless passives)	Full and agentless passives
Spanish	Full passives, agentless passives Case-marked impersonal and object active relatives	Agent phrase demotion (full passives) Agent phrase omission (impersonals and agentless passives)	Full and agentless passives, impersonals Case marking on relative pronoun
Serbian	Infrequent passives Case-marked impersonals and agent-final object active relatives	Agent phrase omission (impersonals and agentless passives)	Agent final actives Case marking on relative pronoun

nounced agents. Since the choice of an active structure in Spanish is manifested early on in the relative pronoun, whatever influence is exerted by competition must play a role at this point, very near the planning of the head noun. This therefore challenges animacy-based word-by-word retrieval assumptions and is consistent with previous studies on planning scope suggesting that the relative clause noun influences initial planning (Smith & Wheeldon, 1999; Wagner et al., 2010).

More critically, the fact that similarity influences morphological and functional choices in Spanish also challenges traditional assumptions of encapsulation and unidirectionality between processing stages in many production models (Bock & Levelt, 1994; Garrett, 1980; Levelt, 1989). Note that for English animate-head cases, it might be possible to argue that competition only occurs at the lemma level and then, the “winning” lemma is mapped onto subject function, whereas the inhibited lemma is simply not pronounced. This arrangement however cannot explain the Spanish data and in particular, the influence of semantic similarity on structural choices (subject vs. object function) and agreement features for active structures (third-person singular vs. impersonal third-person plural), all processes typically taken to occur *after* lemma retrieval. Recall that in Spanish, the planning of animate-head relative clauses results in a higher proportion of passives and active impersonals, compared to inanimate-head ones, and in an equal proportion of active and passives overall within the animate-head condition, with impersonals varying as a function of similarity (see Fig. 4, Fig. 6). The transfer of a single “winning” lemma from the lemma level to the functional level in an encapsulated system does not explain how the semantic relationship between the competing nouns continues to exert an influence at later stages of functional and morphological processing. Specifically, this arrangement is not able to explain why and how either subject or object function can be assigned to this putative winning lemma in Spanish (see Fig. 4) and more generally, why this lemma can receive an object function at all, rather than the most prominent subject function. Therefore, this pattern of results indicates that competition may take place during functional processing and even later, in addition to the lemma selection level.

More generally, the present cross-linguistic data challenge traditional models to specify where and how language specific grammatical rules would play a role in planning, an issue often overlooked. In particular, our data suggest that the ability to assign accusative marking to the head noun via the relative pronoun in Spanish and Serbian may play a role in enabling more active object structures, compared to English. Although this co-variation of structures and case marking may be argued to be coincidental, an attempt to provide a principled reason for its existence would go beyond traditional models, in which the morphological realization of a syntactic function belongs to a later stage of processing and therefore has no role to play in function assignment. Indeed, we have hypothesized that case marking may help alleviate some of the competition occurring at higher levels of planning and this can only happen if feedback from lower to higher levels is allowed. Taken together, these observations suggest that language-specific factors within a more interactive architecture along the lines of those already discussed in the literature (Dell et al., 1999, 2001; Dell & O’Seaghdha, 1992, 1994; Dell et al., 2008) must be brought into play to fully explain the pattern of results that we have uncovered. Below, we provide preliminary examples of how the observed structures might be planned within a more interactive architecture.

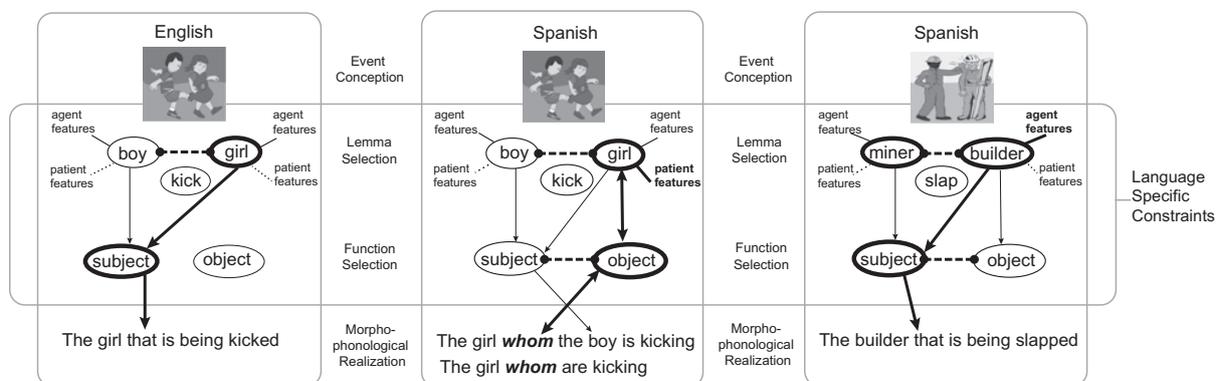
Before we can begin to explain how different languages arrive at different structures, we need to specify where and how language specific constraints are likely to play a role. It is clear that different languages have different structures available (Table 5) and therefore, the number of available alternatives will modulate the strength of the association between the lemmas and a particular syntactic function. Animate head-nouns, for example, are more strongly mapped into subject function in English than Spanish and Serbian, since nearly all animate-head relative clauses in English result in passive structures, unlike Spanish or Serbian. Therefore, language specific constraints are likely to play a role here, i.e., when mapping lemmas to syntactic functions that may be more or less activated due to previous experience with the language.

Moreover, we need to specify the role that specific semantic features play in processing. It can be inferred from our similarity effects that not only the animacy of the nouns but also their specific features play a role in mapping lemmas to syntactic functions: very strong similarity between the nouns led to more passive structures in Spanish (Study 5), whereas the less strong similarity manipulation of Study 2 led to various alternatives. Many previous studies have indeed indicated that noun features, in particular agent- or patient-like features, cue the event role that the nouns play in an event and its

corresponding syntactic function (Ferretti & Gagne, 2006; Ferretti, McRae, & Hatherell, 2001; McRae, Ferretti, & Amyote, 1997; McRae, Hare, Ferretti, & Elman, 2001). For example, inanimate nouns in initial sentence position as in *the evidence examined* . . ., or animate nouns with patient-like feature as in *the young naïve gambler manipulated* . . ., are immediately understood as patients of an upcoming verb because they activate the appropriate patient role. In contrast, initial agent-like animate nouns (e.g., *the man examined by the doctor* . . .) are initially interpreted as agents, leading to garden-path effects (McRae et al., 1997; Trueswell, Tanenhaus, & Garnsey, 1994). Similarly, role reversal errors in children and aphasics suggest that the likelihood with which a noun fulfills the agent or patient role of a verb influences interpretation – for example, *the tiger was killed by the lion* is more difficult to understand than *the mouse was killed by the lion* (Berndt, Mitchum, & Haendiges, 1996; Caramazza & Miceli, 1991; Saffran, Schwartz, & Linebarger, 1998; Turner & Rommetveit, 1967; van der Lely & Harris, 1990). These observations suggest that the nominal features activated during message conception and picture apprehension in our study are already closely linked in conceptual structure to the potential role they can play in the event, and consequently, to the role's most frequently associated syntactic function (e.g., agent-like features cue subject function).

With these properties built into the processing architecture, we can now consider an example of how speakers of different languages may plan a relative clause structure in response to a question such as *who is wearing blue?* (see Fig. 10). Note that Fig. 10 does not include sentence level functions related to the main verb *wear*, and does not include information about the order of mention, as it is assumed that the structure is planned together as a whole. In our experimental design, participants were expected to apprehend the event to be talked about from the picture (e.g., the boy is kicking the girl) and to identify the character corresponding to the query focus (the girl). Therefore, they would have understood the semantic roles played by the concepts in the picture before any linguistic formulation. How do English speakers then map this event into a syntactic structure? The animacy and the agent-like properties of the lemmas elicit competition between them. This is indicated in the figure by dashed lines ending in filled circles. These lemmas compete for the subject function, which in English is the most prominent syntactic function associated with lemmas of these semantic characteristics, as indicated by the arrows linking both lemmas to the subject function. This competition is resolved in favor of the lemma bearing the query focus, which makes it more highly active, and thus, it is mapped into the subject function. In contrast, the lemma that has been inhibited as a result of competition is not pronounced.

Consider Spanish structures now. In Spanish, the strength of the association between lemmas and functions appears more balanced towards either subject or object function than in English because this language has more flexible word order and explicit object marking, and consequently, more alternative ways to deal with competition. Spanish speakers indeed can equally map the lemmas into a passive structure (subject function) or an active structure (object function), as they did in Study 2.



**Fig. 10.** Examples of how different cross-linguistic choices may emerge from the same production architecture. Line thickness in circles indicates different levels of activation, with dotted lines being less active. Dashed lines ending in filled circles indicate competition. Arrow thickness indicates the strength of the association between the lemmas and their properties, and a syntactic function in a particular language.

What determines the choice of subject or object function here? As in English, the agent-like properties of the lemmas interfere with each other during formulation and compete for syntactic functions. Syntactic functions also compete with each other because both object and subject function are initially equally active, perhaps activating or re-activating the agent and patient properties of the lemmas to arrive at the appropriate assignment. Patient-like features in this example are likely to be more active for the girl lemma (girls are less likely to kick, and physically weaker) than agent-like features, albeit within a highly competitive environment due to both nouns being agent-like overall. In Spanish speakers' linguistic experience, these patient-like features are strongly associated with object function and object marking, and therefore will prime them, increasing their activation level. At the same time, the activation of object marking in the structure, which is planned very near the head noun, provides additional activation and feedback to higher levels, thus easing semantic and functional competition (bidirectional information flow). This competition across the network may result in an active object relative or impersonal, depending on the degree of semantic competition and the extent to which the agent lemma is inhibited: strong inhibition of this lemma results in an impersonal structure, whereas less inhibition results in an active object relative, where the subject function is realized.

We suspect that the activation level of the case-marked object function in Spanish depends on the strength of the association between the head-lemma's patient-related features and the object function in linguistic experience, which may vary across items. If this association is relatively strong, as with inanimate objects, animal or baby event participants, all of which are more likely to be patients, the object function will be more strongly activated from the conceptual level. However, if this association is relatively weak, or if competition is too high because both animate lemmas are equally likely to be agents or patients (as in Study 5), a subject function would be selected resulting on a passive structure, because the object-marking would not be strongly activated from the conceptual information, and more agent-like features would dominate both competing concepts.

Consider Serbian structures now. In this language, the speakers' linguistic experience with case marking and the low availability of passives (subject function) in these contexts would usually lead to stronger associations between patient features and object marking and thus, active structures. This would lead to a situation like that in Spanish object relatives in Fig. 10, where patient features prime object function and marking and these in turn, feed back to higher levels to alleviate competition. It would be only rarely that the availability of strong agent features relative to some verbs/events would tip the balance towards a passive structure.

Of course, the possibility that competition occurs at different processing stages clearly requires more research, as the timing of the competition processes discussed here is not known. Future research may for example examine planning times to establish the difficulty associated with competition before speech onset. We would expect that in the planning of animate-head structures, all languages should show longer planning times initially, even though there should also be competition at the functional level when alternative structures are equally available, as with English inanimate-head structures (Montag and MacDonald, 2011). More interestingly, we would expect Spanish and Serbian active relative clauses to reveal planning difficulty when two animate nouns are part of the structure, as compared to structures with an animate and an inanimate noun, despite the presence of case marking. Comparisons across languages are particularly relevant here because if planning times differ across languages, this would provide additional insights about the interplay of language-specific factors and production processes.

In sum, our results clearly suggest that an accessibility-based retrieval-order view to sentence planning needs to be further qualified. Animacy alone does not appear to determine the order in which nouns are retrieved and their functions assigned. Nouns do not seem to be retrieved strictly in the order they are formulated and syntactic function assignment does not appear to simply operate on the most salient and accessible lemma selected after competition. These findings therefore challenge traditional assumptions of strict encapsulation and unidirectionality in which each stage of processing, e.g., lemma selection, is completed before subsequent stages, and are consistent with more interactive production models where processes at the conceptual level may cascade into or interact with other levels (Dell et al., 1999, 2001; Dell & O'Seaghdha, 1992, 1994; Dell et al., 2008). Such interactive models are supported by findings in agreement phenomena suggesting that information flow between both conceptual and functional processes, on the one hand, and functional and positional processes,

on the other hand, appears interactive, rather than encapsulated (Hartsuiker, Schriefers, Bock, & Kikstra, 2003; Haskell & MacDonald, 2005; Vigliocco & Hartsuiker, 2002).

### 8.3. Implications for the relationship between production and comprehension

As we noted in the introduction, active object relative clauses with animate heads, such as *The man that the woman is punching*, are known to be difficult to comprehend. The Production Distribution Comprehension (PDC) account of language processing has suggested that this result can be traced directly to language production (Gennari & MacDonald, 2009; MacDonald, 1999). In this account, production mechanisms promote certain utterance forms over others, yielding broad distributional patterns in the language, which are then learned and used by language users to guide subsequent comprehension. Many studies have shown for example that active object relative clauses with two animate nouns such as *the man that the woman is punching* are more difficult to comprehend than active subject relatives such as *the woman that is punching the man* (Gordon et al., 2001; King & Just, 1991; MacWhinney & Pleh, 1988; Traxler et al., 2002). The PDC account suggests that this comprehension difficulty is due to the fact that such active object structures with two animate nouns are rarely produced, as suggested by corpus studies (Fox & Thompson, 1990; Gennari & MacDonald, 2009; Mak et al., 2002). Thus, when comprehenders are faced with *the man that the woman is punching*, as the sentence unfolds over time, they activate and predict several likely alternatives, which conflict with the unfolding input, generating comprehension difficulty (Gennari & MacDonald, 2008, 2009). Our current results indeed confirm that English speakers are clearly reluctant to produce active object relatives with two animate nouns, and instead prefer to produce passive (subject relative) structures, as *the man that is being punched*.

Importantly, the present results also provide an explanation for why the production preferences affecting relative clause comprehension have the specific shape they do: similarity-based competition and animacy-based saliency together lead English speakers to produce passive relatives instead of active relatives when two animate nouns are to be talked about. Interestingly, there is evidence that within the category of animate-headed object relatives, sentences containing highly similar nouns appear to be especially difficult to comprehend. Gordon et al. (2001) found that object relatives with two profession nouns (e.g., *The dancer that the reporter phoned. . .*) were more difficult than those in which the agent noun was replaced with a proper name or pronoun (e.g. *Ann* or *you*), and Acheson and MacDonald (2011) found that object relatives with phonologically overlapping nouns (*baker/banker*) were more difficult than those with non-overlapping nouns (Acheson & MacDonald, 2011). As we noted in the introduction, Gordon et al. (2001) and other researchers (e.g., Van Dyke & Lewis, 2003) ascribe effects such as these to interference within comprehension processes, but our results concerning the effects of noun similarity on production behavior suggest an alternative view: that the special difficulty with object relatives containing highly overlapping nouns is a function of the distributional regularities in the language, owing to producers' especially strong avoidance of these forms. It remains to be seen whether languages such as Spanish, in which production choices are more varied, also show corresponding comprehension behavior as a result of their distributional preferences.

Finally, it is possible that production and comprehension are not only related via the emergence of distributional patterns but also by similar competition mechanisms operating in both tasks. Whether production and comprehension share processing mechanisms or only a common knowledge base that has been learned from linguistic experience remains an open issue and existing evidence appears consistent with both views (Bock, Dell, Chang, & Onishi, 2007; Chang et al., 2006; Pickering & Garrod, 2007). Precisely timed studies using cross-modal priming may help elucidate these issues by establishing the point in time at which similarity-based competition occurs in both production and comprehension.

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.cogpsych.2012.03.002>.

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