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# Conceptual influences on word order and voice in sentence production: Evidence from Japanese

Mikihiro N. Tanaka [a,*], Holly P. Branigan [b], Janet F. McLean [b], Martin J. Pickering [b]

[a] School of Arts and Sciences, Showa University, 4562 Kamiyoshida, Fujiyoshida-shi, Yamanashi-ken, 403-0005, Japan
[b] Department of Psychology, University of Edinburgh, 7 George Square, Edinburgh EH8 9JZ, United Kingdom

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ABSTRACT

Two experiments using a sentence recall task tested the effect of animacy on syntactic processing in Japanese sentence production. Experiment 1 and 2 showed that when Japanese native speakers recalled transitive sentences, they were more likely to assign animate entities earlier positions in the sentence than inanimate entities. In addition, Experiment 2 showed that they were more likely to recall animate entities than inanimate entities as sentence subjects in active and passive sentences. Thus conceptual information influenced both the way in which grammatical functions were assigned and choice of word order. We consider the implications of these findings for theories of language production.



## Introduction

When a speaker produces an utterance, she must choose a syntactic structure to realize her intended message. There is strong evidence that conceptual information can influence this choice. A number of studies have shown that syntactic structure tends to be affected by the conceptual properties of the entities that are involved in an event. For example, entities that are prominent as a result of properties such as concreteness (Bock & Warren, 1985), prototypicality (Kelly, Bock, & Keil, 1986), or animacy (Ferreira, 1994; McDonald, Bock, & Kelly, 1993) or as a result of contextual manipulations such as semantic priming (Bock, 1986), prior mention in the discourse (Bock, 1977; Bock & Irwin, 1980), or salience in the discourse (Christianson & Ferreira, 2005; Prat-Sala & Branigan, 2000) tend to appear as sentence-initial subjects. For this to happen, there must be some relationship between conceptual information and linguistic form. In this paper, we investigate the nature of this relationship: Are conceptual features associated with variations in grammatical function assignment, word order, or both; and what does this association tell us about the nature of language production?

Language production is generally assumed to involve three main stages: *conceptualization*, during which the message to be expressed is determined; *formulation*, which is concerned with translating the message into linguistic form; and *articulation*, which realizes the ensuing linguistic structure as a series of motor movements (e.g., Levelt, 1989). Processing in each stage is treated as incremental, such that the processor deals with information in the order in which it is retrieved (e.g., Bock, 1982; Kempen & Hoenkamp, 1987; Levelt, 1989). Most models assume that two types of representation are computed during grammatical encoding: the grammatical relations that define the role that each nominal element plays in the utterance (e.g., subject, direct object), and the hierarchical and linear relations that define how individual words are combined into complex expressions (constituent structure). The best-known models of production assume that grammatical relations are assigned in an initial stage of processing, *functional processing*, that maps from the conceptual representation to an unordered set of *lemmas* (the syntactic components

* Corresponding author. Address: Faculty of Arts and Sciences, Showa University, 4562 Kami-yoshida, Fujiyoshida-shi, Yamanashi-ken 403-0005, Japan. Fax: +81 555 22 2137.
*E-mail address:* mtanaka@cas.showa-u.ac.jp (M.N. Tanaka).

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of lexical entries) that are tagged for grammatical function (e.g., Bock & Levelt, 1994; Garrett, 1975; Levelt, 1989). Constituent structure (including word order) is determined during a subsequent stage of *positional processing*.

Bock and Warren (1985) suggested that conceptual features might influence syntactic structure by affecting the order in which elements are retrieved and hence undergo grammatical encoding. Specifically, they proposed that conceptual representations vary in their *conceptual accessibility*, or the speed with which they can be retrieved from memory, which Bock and Warren linked to variations in predicability: Entities that are highly predicable – in other words, can occur in many conceptual relations – have more pathways to retrieval and are therefore retrieved more quickly than less predicable entities. Assuming incremental processing, conceptually more accessible entities should therefore undergo grammatical encoding before conceptually less accessible entities.

But how exactly might conceptual accessibility affect syntactic structure? Bock and Warren (1985; see also Bock, 1987; Bock, Loebell, & Morey, 1992) proposed that conceptual accessibility influences the process of grammatical function assignment. In their account, which we will term the *grammatical function account*, grammatical functions are assigned according to a *noun phrase accessibility hierarchy* (Keenan & Comrie, 1977), such that the subject function is assigned first, followed by direct object, indirect object, and oblique object. Because accessible concepts are retrieved more quickly, they tend to claim higher grammatical functions. Hence conceptually accessible entities become subjects more often than conceptually inaccessible entities. Thus active sentences should be more likely when the more accessible entity is the agent of a transitive action than when it is the patient, but passive sentences should be more likely when the more accessible entity is the patient than when it is the agent. Crucially, Bock and Warren claimed that conceptual accessibility could not directly influence choice of word order.

In other accounts, which we will term *word order accounts*, conceptual accessibility can influence word order. Although they differ in details, these accounts allow conceptually more accessible entities to claim early word order positions, irrespective of grammatical function (e.g., De Smedt, 1990; Kempen & Hoenkamp, 1987). For example, in Kempen and Hoenkamp's model, lemmas are assigned grammatical functions before they claim a word order position; but functions are not assigned in a specified order, and whichever lemma receives a grammatical function first claims the earliest available position. Thus an object can claim first position before the subject function has been assigned. In this model, early positions are thus mediated via an initial stage of grammatical function assignment. De Smedt (1990) proposed a slightly different model in which conceptual accessibility is directly associated with early word order positions, without a mediating stage of grammatical function assignment. Word order accounts therefore predict that word orders in which conceptually accessible entities precede conceptually inaccessible entities should be more likely than word orders in which conceptually inaccessible entities precede conceptually accessible entities. It is not clear in existing word order accounts whether conceptual accessibility additionally affects grammatical function assignment.

Much of the evidence that conceptual accessibility affects syntactic structure cannot distinguish between the two types of account. For instance, demonstrations that concrete, prototypical, given, or animate entities are more likely than abstract, non-prototypical, new, or inanimate entities to appear as sentence-initial subjects (e.g., Bock, 1977; Bock & Warren, 1985; Ferreira, 1994; Kelly et al., 1986; McDonald et al., 1993; van Nice & Dietrich, 2003) could be explained in terms of an association between conceptual accessibility and subjecthood (in keeping with the grammatical function account), conceptual accessibility and early word order positions (in keeping with word order accounts), or both. In large part, this difficulty in distinguishing between the accounts arises because most research has been carried out in English, which allows very little variation in word order independent of variation in grammatical function. For example, in English the subject is almost always the first noun phrase in the sentence. Exceptions such as topicalizations (e.g., *Ice cream, I really like*) tend to be heavily restricted in their use.

However, some research has distinguished grammatical function from word order effects. Bock and Warren (1985) had participants listen to and subsequently recall phrases and sentences involving two nouns that differed in conceptual accessibility (as indexed by imageability; Paivio, 1971). In keeping with other work (e.g., Bock, 1977; Bock & Irwin, 1980; Potter & Lombardi, 1990; see also Bock, 1996), Bock and Warren assumed that sentence recall can be informative about the normal processes of language production. People are generally good at recalling the gist of a sentence (i.e., the message), but not its exact form (Jarvella, 1971; Potter & Lombardi, 1990). Sentence recall therefore involves mapping a message onto linguistic form, and as such appears to reflect the biases of the normal processes of language production. In particular, participants tend to recall sentences in a form different to that originally presented if the original form conflicts with the form that they would choose during spontaneous production.

Bock and Warren (1985) included a set of sentences in which the nouns appeared as the subject and direct or oblique object of active/passive sentences (e.g., *The doctor administered the shock* vs. *The shock was administered by the doctor*) and a set in which they appeared as conjuncts in a noun phrase conjunction (e.g., *The hiker fought winter and time* vs. *the hiker fought time and winter*). Note that in noun phrase conjunctions, both entities have the same grammatical function (here, direct object). Participants tended to recall active/passive sentences in a way that allowed the concrete entity to appear with a high grammatical function, recalling passive sentences involving a concrete agent as actives (e.g., recalling *The shock was administered by the doctor* as *The doctor administered the shock*), but recalling active sentences involving a concrete patient as passives. In contrast, they did not tend to recall sentences involving noun phrase conjunctions in orders that placed the concrete entity first: *The hiker fought time and winter* was not recalled as *The hiker fought winter and time*. They argued that their results suggest a model in which conceptual accessibility affects the assignment of grammatical function but does not independently affect word order.

McDonald et al. (1993) found supporting evidence in a study that focused on animacy as an index of conceptual accessibility. As in Bock and Warren (1985), participants heard and subsequently recalled transitive sentences and noun phrase conjunctions involving one animate and one inanimate entity. They were more likely to erroneously recall animate entities as subjects (e.g., *The music soothed the child* recalled as *The child was soothed by the music*) than to erroneously recall inanimate entities as subjects, but there was no effect of animacy on word order in noun phrase conjunctions: Participants were equally likely to recall the inanimate entity first (e.g., *The telephone and the dog were both making noise*) as the animate entity first (*The dog and the telephone were both making noise*).

Taken together, these results support the grammatical function account. However, other evidence suggests an alternative locus for conceptual accessibility effects on production. For example, Christianson and Ferreira (2005) found that variations in animacy affected Odawa speakers' choice of sentence type, independent of grammatical function. Thus Odawa speakers' choice of active structures (in which the agent appeared as the subject and the patient as the direct object) vs. inverse structures (in which the agent also appeared as the subject and the patient as the direct object, but in which the object received emphasis) was affected by (degree of) animacy, with more inverse structures when the agent was an animal and the patient was human than vice versa.

Other evidence provides more direct support for word-order accounts of conceptual accessibility effects. First, a number of studies suggest that conceptual factors influence word order in English noun phrase conjunctions. Cooper and Ross (1975) found that animates tend to precede inanimates in conjunctions whose form is relatively 'frozen' (*men and machines*; *animal, vegetable, or mineral*). Byrne and Davidson (1985) found that children were more likely to correctly recall noun phrase conjunctions when the referent of the first conjunct was animate than when it was inanimate. Finally, Kelly et al. (1986) found effects of prototypicality on word order in a recall study: Prototypical entities tended to precede non-prototypical entities in noun-phrase conjunctions (e.g., *an apple and a lemon*), and also tended to appear as (sentence-initial) subjects (e.g., *The ring scratched the brooch in the jewellery box*). Using the same methodology, Onishi, Murphy, and Bock (2008) found that entities that were typical of a particular semantic category tended to precede less typical entities in noun-phrase conjunctions, when both entities were drawn from the same established category; in contrast, typicality did not reliably affect ordering of noun phrases in sentences when differences in ordering were associated with different grammatical roles (e.g., *A turkey took a walk around a lake with a robin* vs. *A robin took a walk around a lake with a turkey*). Note however that such evidence contrasts with the failure to find conceptual accessibility effects on conjunct order in Bock and Warren (1985) and McDonald et al. (1993), and typicality may not in fact be an index of conceptual accessibility, as indexed by predicability; we return to this point in the "General discussion".

But most of the research favoring word order accounts comes from languages with less restrictive word orders. In a corpus study, Kempen and Harbusch (2004) found that animate entities tended to precede inanimate entities in German ditransitives when grammatical function was controlled; for example the direct object preceded the subject more frequently when the direct object was animate and the subject was inanimate than when the direct object was inanimate and the subject was animate. Sridhar (1988) had participants 'just describe' a series of videotaped events (cf. Osgood, 1971) in many languages, some with highly flexible word order. Participants tended to produce descriptions that allowed conceptually accessible entities to appear first; for some languages, these effects could not be explained in terms of grammatical function assignment. Prat-Sala and Branigan (2000) found that participants in a Spanish picture-description task were more likely to produce not only descriptions with animate subjects (e.g., *La mujer fue atropellada por el tren*: 'The woman was run over by the train'), but also descriptions in which animate entities appeared as sentence-initial direct objects (*A la mujerla atropello el tren*: 'The woman, the train ran her over'), than descriptions with inanimate sentence-initial subjects. The former effect might reflect a preference either to make animate entities subjects or to place them early, but the latter effect must reflect a preference to place them early. Similarly, Ferreira and Yoshita (2003) found that Japanese participants tended to recall previously encountered (hence, more accessible) entities before new (less accessible) entities even though these different word orders involved assigning the same entities to the same grammatical functions.

Branigan and Feleki (1999) directly examined whether animacy influences word order by studying sentence recall in Greek, which allows the same grammatical function assignment to be realized in different word orders. They manipulated animacy of the subject noun (animate-subject vs. inanimate-subject noun) and the word order of the presented sentence (preferred Subject Verb Object [SVO] vs. dispreferred Object Verb Subject [OVS] order). Participants preferred to recall sentences in a form that allowed an animate entity to precede an inanimate entity, both for SVO and OVS order. For example, they were more likely to recall SVO sentences as OVS sentences when the subject was inanimate and the effect was to place the animate entity in first position (e.g., *Sta dimokratika politevmata, to sindagm*$_{NOM}$ *sevete ton politi*$_{ACC}$; 'In democratic regimes, the law$_{SUBJ}$ respects the citizen$_{OBJ}$' recalled as *Sta dimokratika politevmata, ton politi*$_{ACC}$ *sevete to sindagm*$_{NOM}$; 'In democratic regimes, the citizen$_{OBJ}$ respects the law$_{SUBJ}$') than when the subject was inanimate and the effect was to place the inanimate entity in first position. Their experiment showed that conceptual accessibility can directly affect word order; but it did not show whether it additionally affects grammatical function assignment.

In sum, there is conflicting evidence concerning the nature of conceptual influences on choice of syntactic structure in language production. Some experimental data suggest that conceptual factors affect grammatical function assignment but not word order (e.g., Bock & Warren, 1985; McDonald et al., 1993), and therefore support the grammatical function account. But other data from experiments (e.g., Kelly et al., 1986; Branigan & Feleki, 1999) and text corpora (Kempen & Harbusch, 2004) suggest that conceptual factors affect word order directly, and therefore support word order accounts.

Nor is it known whether such effects exist alongside, or in place of, a hypothesized role for conceptual factors in grammatical function assignment.

We now report two experiments that investigated how conceptual accessibility affects syntactic choice by independently manipulating grammatical function assignment and word order in a sentence recall task in Japanese. Japanese has a relatively flexible word order that allows the same grammatical function assignment to be realized in different word orders. In particular, the grammatical function assignment associated with an active structure (agent = subject; patient = direct object) can be realized in an SOV word order (the preferred word order; 1a) and also in an Object Subject Verb [OSV] order (1b). Similarly, the function assignment associated with a passive structure (patient = subject; agent = oblique object) can be realized in an SOV (2a) or an OSV (2b) order (among others). (Because we are concerned with assignment of the subject function vs. other functions, we will refer to both direct objects and oblique objects using the umbrella term *object*.) As in English, Japanese noun phrase conjunctions also allow alternative orders, such that two conjuncts (bearing the same grammatical function) can appear in either order (3a and b). Note that -$_{NOM}$ denotes nominative case; -$_{ACC}$ denotes accusative case; -$_{ACT}$ denotes active voice; -$_{PAS}$ denotes passive voice.

(1a) ボートが漁師を運んだ。(Active SOV sentence)
booto-ga ryoshi-o hakonda.
boat-$_{NOM}$ fisherman-$_{ACC}$ carried-$_{ACT}$
*'The boat carried the fisherman.'*

(1b) 漁師をボートが運んだ。(Active OSV sentence)
ryoshi-o booto-ga hakonda.
fisherman-$_{ACC}$ boat-$_{NOM}$ carried-$_{ACT}$
*'The fisherman, the boat carried.'*

(2a) 漁師がボートによって運ばれた。(Passive SOV sentence)
ryoshi-ga booto-niyotte hakobareta.
fisherman-$_{NOM}$ boat-$_{OBL}$ carried-$_{PAS}$
*'The fisherman was carried by the boat.'*

(2b) ボートによって漁師が運ばれた。(Passive OSV sentence)
booto-niyotte ryoshi-ga hakobareta.
boat-$_{OBL}$ fisherman-$_{NOM}$ carried-$_{PAS}$
*'By the boat, the fisherman was carried.'*

(3a) ボートと漁師が動いていた (NP conjunction sentence (*A and B* order))
booto to ryoshi-ga ugoiteita.
boat and fisherman-$_{NOM}$ were moving.
*'The boat and the fisherman were moving.'*

(3b) 漁師とボートが動いていた。(NP conjunction sentence (*B and A* order))
ryoshi to booto-ga ugoiteita.
fisherman and boat-$_{NOM}$ were moving.
*'The fisherman and the boat were moving.'*

Our experimental sentences all involved an animate entity and an inanimate entity. Participants heard and subsequently recalled blocks of 8 sentences that comprised an initial adverbial phrase (e.g., *In the harbor...*) followed by a main clause. In Experiment 1, we examined recall of word order variations when the main clause involved transitive actions with two entities (e.g., *The boat carried the fisherman*) and when the main clause involved intransitive actions with a conjoined subject noun phrase (e.g., *The boat and the fisherman were moving*). If animacy affects the choice of word order, then participants should tend to recall sentences in a form that places the animate entity before the inanimate entity, regardless of grammatical function assignment. Hence when recalling an active sentence in which the animate entity appears after the inanimate entity, they should invert the word order of the sentence so that the animate entity instead appears preceding the inanimate entity (e.g., recalling *The boat$_{OBJ}$ the fisherman$_{SUBJ}$ carried* as *the fisherman$_{SUBJ}$ the boat$_{OBJ}$ carried*). If animacy affects word order in main clauses but not in noun phrase conjunctions, then participants should tend to recall main clauses but not noun phrase conjunctions in a form that places the animate entity before the inanimate entity.

Experiment 2 examined recall of sentences involving variations in word order and additionally variations in grammatical function assignment. If animacy affects grammatical function assignment, then participants should tend to recall sentences in a form that makes the animate entity the subject, regardless of word order. Hence when recalling an active sentence in which the animate entity appears as the object, they should invert the voice of the sentence so that the animate entity instead appears as the subject of a passive sentence (e.g., recalling *The boat$_{SUBJ}$ the fisherman$_{OBJ}$ carried* as *The fisherman$_{SUBJ}$ by the boat$_{OBJ}$ were carried*). Conversely, when recalling a passive sentence in which the animate entity appears as the object, they should invert the voice so that the animate entity instead appears as the subject of an active sentence (e.g., recalling *The boat$_{SUBJ}$ by the fisherman$_{OBJ}$ was carried* as *The fisherman$_{SUBJ}$ the boat$_{OBJ}$ carried*).

## Experiment 1

### *Method*

#### *Participants*

Forty-eight native speakers of Japanese participated for payment. They were recruited at the Universities of Edinburgh and Essex. Data from 12 additional participants were excluded (see "Procedure").

#### *Items*

We constructed 42 items such as those in (4–6), each comprising a locative prepositional phrase (the *preamble*)

and a main clause that contained an animate noun and an inanimate noun. Each item had six versions, all containing the same prepositional phrase and noun phrases. Four versions contained a transitive verb; the remaining two versions contained an intransitive verb. The six versions of each item were constructed by crossing animacy of the first noun (animate-first [An-first] vs. inanimate-first [In-first]) with structure (SOV vs. OSV vs. NP Conjunction [Conj]). In addition, we constructed 22 filler sentences containing a locative prepositional phrase, an intransitive verb, and a noun; 11 had an animate agent and 11 had an inanimate agent.

(4a) 港で,漁師がボートを運んだ。(An-first SOV)
minato de, ryoshi-ga booto-o hakonda.
Harbor in, fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$
*'In the harbor, the fisherman carried the boat.'*

(4b) 港で,ボートが漁師を運んだ。(In-first SOV)
minato de, booto-ga ryoshi-o hakonda.
Harbor in, boat-$_{NOM}$ fisherman-$_{ACC}$ carried-$_{ACT}$
*'In the harbor, the boat carried the fisherman.'*

(5a) 港で,漁師をボートが運んだ。(An-first OSV)
minato de, ryoshi-o booto-ga hakonda.
Harbor in, fisherman-$_{ACC}$ boat-$_{NOM}$ carried-$_{ACT}$
*'In the harbor, the fisherman, the boat carried.'*

(5b) 港で,ボートを漁師が運んだ。(In-first OSV)
minato de, booto-o ryoshi-ga hakonda.
Harbor in, boat-$_{ACC}$ fisherman-$_{NOM}$ carried-$_{ACT}$
*'In the harbor, the boat, the fisherman carried.'*

(6a) 港で,漁師とボートが動いていた。(An-first Conj)
minato de, ryoshi to booto-ga ugoiteita.
Harbor in, fisherman and boat-$_{NOM}$ were moving.
*'In the harbor, the fisherman and the boat were moving.'*

(6b) 港で,ボートと漁師が動いていた。(In-first Conj)
minato de, booto to ryoshi-ga ugoiteita.
Harbor in, boat and fisherman-$_{NOM}$ were moving.
*'In the harbor, the boat and the fisherman were moving.'*

To exclude the possibility that word order changes reflected associations between particular nouns and preambles, a pretest established that the animate and inanimate nouns were semantically associated with the preamble to the same extent. Twenty further native speakers of Japanese judged on a 1–10 scale how closely each experimental noun (e.g., *fisherman*, *boat*) was associated with its preamble noun (*harbor*). There were no significant differences between the animate and inanimate nouns (means: 6.76 vs. 6.51, $t < 1$). (We also tested six additional animate nouns and six additional inanimate nouns with associated preamble nouns; these were not used in this experiment, but were used in Experiment 2.) We also calculated the frequencies of the 42 animate and inanimate noun combinations from the approximately 290 million-word Nippon Telegraph and Telephone Corporation (NTT) corpus (Amano & Kondo, 2001) and found no differences between the animate and inanimate nouns (mean frequency 8666 vs. 11,242 occurrences, $t < 1$). Thus, any word order changes could not reflect frequency differences between the nouns.

The items were placed into six lists, each comprising 64 sentences (42 experimental sentences and 22 filler sentences) and one version of each item. Each version of an item was seen by eight participants, and each participant saw seven items in each condition.

*Procedure*

The sentence recall task used in this experiment was similar to that used in Bock and Warren (1985) and McDonald et al. (1993). Participants were seated in a quiet room and tested individually. The sentences were presented on audiotape in eight blocks, each containing eight sentences, of which at least two were fillers. The order of sentences within each block was randomized; the resulting order did not change across all six lists. A 4 s pause separated each recorded sentence in each block. After each block of sentences, participants were prompted for oral recall using the preambles (e.g., *In the harbor...*) in a different randomized order. Participants were required to respond within 8 s. They completed two blocks of eight practice sentences before the main experiment, each comprising two SOV sentences, two OSV sentences, two NP conjunction sentences, and two intransitive sentences. All answers were recorded on Mini Disk audio tapes and were subsequently transcribed. The experimental session lasted about 30 min.

*Scoring*

Participants' responses were grouped into five categories: Correct, Word order inversion, Voice inversion, Word order + Voice inversion, and Other (see Table 1). Responses were scored as *correct* when participants recalled correctly the meaning, the verb and both nouns (or synonyms or near-synonyms of those words, e.g., *taxi–car*), and the syntactic structure and word order that had been originally presented. Responses were scored as *word order inversions* when participants recalled correctly the meaning and the lexical content, but recalled the alternative word order to that presented (e.g., an SOV sentence recalled with OSV order, or an NP conjunction recalled with the order of the animate and inanimate entities reversed). Responses were scored as *voice inversions* when participants recalled correctly the meaning, the lexical content and the word order that had been presented, but the patient was assigned the subject function and the agent was assigned the oblique object function (e.g., an SOV active sentence recalled as an SOV passive sentence). Responses were scored as *word order + voice inversions* when participants recalled correctly the meaning and the lexical content, but recalled the alternative word order and the alternative voice to that pre-

**Table 1**
Experiments 1 and 2: Example responses in each scoring category.

| Score | Original sentence | Recalled as |
|---|---|---|
| Correct | Fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$ | Fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$ |
| Word order inversion | Fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$ | Boat-$_{ACC}$ fisherman-$_{NOM}$ carried-$_{ACT}$ |
| Voice inversion | Fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$ | Boat-$_{NOM}$ fisherman-$_{OBL}$ carried-$_{PAS}$ |
| Word order + voice inversion | Fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$ | Fisherman-$_{OBL}$ boat-$_{NOM}$ carried-$_{PAS}$ |
| Other | Fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$ | Boat-$_{NOM}$ carrying fisherman-$_{ACC}$ |

sented (e.g., an SOV active sentence recalled as an OSV passive sentence). All other responses were scored as *Other*.

We excluded the responses of 12 participants who correctly recalled the meaning of fewer than 30% of sentences, and responses from seven items that could have had alternative interpretations than those intended or were potentially infelicitous.

*Results*

The frequency of Correct, Word order inversion, Voice inversion, Word order + Voice inversion, and Other responses for each Word Order and Animacy of the first noun are shown in Table 2. Fig. 1 shows the proportion of word order inversions in Experiment 1. We were interested in the conditions under which participants inverted the order of animate and inanimate entities but otherwise recalled the sentence correctly. We therefore focused on those trials on which participants recalled all aspects of the sentence correctly except for the word order (i.e., responses scored as word order inversions) and those where they recalled the sentence correctly (the percentages reported below for ease of exposition are therefore calculated over the total number of word order inverted and correctly recalled sentences in each condition). Because the SOV/OSV conditions and the NP Conjunction condition can be considered to represent different structure types, we conducted two separate analyses: The first analysis modeled the number of word order inversions in SOV vs. OSV conditions; the second analysis modeled the number of word order inversions in NP Conjunction vs. transitive (i.e., SOV and OSV) conditions.

As the dependent variable (Response) was binomial (correct or word order inversion) for each analysis, we modeled the responses using logit mixed effects models (Breslow & Clayton, 1993; Debroy & Bates, 2004). Mixed

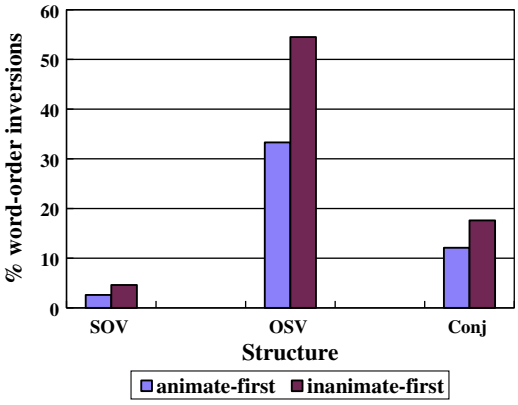


**Fig. 1.** Experiment 1: Percentage of word order inversions on recall by condition.

models allow the simultaneous inclusion of by-participant and by-item variation and thus remove the need for separate F1 and F2 analyses. These models can be thought of as predicting the probability of a specific response (a word order inversion response) in the different conditions (see Agresti, 2002; Jaeger, 2008).

Factor labels were transformed into numerical values, and centered prior to analysis, so as to have a mean of 0 and a range of 1. This procedure minimizes collinearity between variables (Baayen, 2008), and, in combination with sum coding of contrasts, allows coefficients to be interpreted in an analogous way to the main effects and interactions in an Analysis of Variance. For each result, we report the coefficient for each independent variable and its level of significance. Coefficients in mixed logit models are given in log-odds. Significant positive coefficients show that a passive target response is more likely in the tested level of the variable than in the other.

We ran mixed logit models with Animacy of the first noun, Word Order, and all the two-way interactions between them as fixed factors, and participant and items as random effects. Random slope parameters were included in the models using forward selection (Baayen, 2008). Random slope parameters for main effects and interactions were added sequentially, first for participants, and then for items. The final model incorporated only those random slope parameters whose inclusion resulted in a better model fit than simpler models.

The best fit models for both analyses are summarized in Table 3. For SOV and OSV, none of the interactions reached

**Table 2**
Experiment 1: The frequency of responses for animacy of first noun and word order.

| Animacy | Word order | Recalled responses | | | | |
|---|---|---|---|---|---|---|
| | | Correct | Word order inversion | Voice inversion | Word order + voice inversion | Other |
| Animate | SOV | 161 | 3 | 1 | 0 | 115 |
| | OSV | 77 | 46 | 11 | 0 | 146 |
| | Conj. | 132 | 20 | 1 | 0 | 127 |
| Inanimate | SOV | 147 | 8 | 3 | 1 | 121 |
| | OSV | 63 | 81 | 4 | 0 | 132 |
| | Conj. | 130 | 30 | 0 | 0 | 120 |

**Table 3**
Model coefficients and probabilities for best-fitting models. The intercept represents the log-odds for the specified response (word order inversion). The "Slope" column indicates whether the random slope parameter corresponding to the effect was included in the model for participants ($p$) or items (i).

| Word order | Predictor | Coefficient | Std. error | Wald $Z$ | $p$ (coefficient $\neq 0$) | Slope |
|---|---|---|---|---|---|---|
| SOV and OSV | Intercept | −2.51 | 0.31 | −8.19 | <.001 | |
| | Animacy | 1.13 | 0.39 | 2.91 | <.01 | ($p$)(i) |
| | Word Order | −4.63 | 0.69 | −6.73 | <.001 | ($p$)(i) |
| NP conjunction | Intercept | −1.57 | 0.13 | −11.7 | <.001 | |
| | Animacy | 0.70 | 0.18 | 3.96 | <.001 | |
| | Word Order | 0.52 | 0.19 | 2.79 | <.01 | |

significance and hence were removed from the model ($p > .7$). Critically, there was a main effect of Animacy of the first noun; participants recalled more word order inversion responses following an inanimate first noun (15%) than an animate first noun (8%). There was also a main effect of Word Order; participants recalled more word order inversion responses following OSV sentences (22%) than following SOV sentences (2%). Simple main effects revealed no effect of Animacy of the first noun for SOV sentences (log-odds coefficient $B = 1.11$ ($SE = 0.77$), $p = .15$). However, OSV sentences showed a significant effect of Animacy of the first noun (log-odds coefficient $B = 0.90$ ($SE = 0.28$), $p < .01$); participants recalled more word order inversions for inanimate first nouns (30%) than animate first nouns (17%).

For the NP Conjunction sentences, Word Order was recoded to yield two categories: NP Conjunction or Transitive. This new factor was treated like the other factors and centered prior to analysis. None of the interactions reached significance, and were hence removed from the model ($p > .4$). There was a main effect of Animacy of the first noun; participants recalled more word order inversion responses following an inanimate first noun (13%) than an animate first noun (8%). There was also a main effect of Word Order; participants recalled more word order inversion responses following sentences that were Transitives (15%) than following sentences that were NP Conjunctions (6%). Simple main effects for the NP Conjunctions showed no main effect of the Animacy of the first noun (log-odds coefficient $B = 0.45$ ($SE = 0.32$), $p = .16$).

### *Discussion*

The results of Experiment 1 showed that participants tended to recall sentences in the preferred SOV order. But more importantly, this tendency was affected by the animacy of the subject and object nouns: Participants were more likely to recall OSV sentences as SOV sentences when this resulted in the animate entity preceding the inanimate entity than when it resulted in the inanimate entity preceding the animate entity. In other words, even when grammatical function was held constant, there was a stronger preference to produce sentences in which the animate entity appeared in an early sentence position than sentences in which the inanimate entity appeared in an early position. Hence, Experiment 1 suggested that animacy directly affects word order choice in Japanese transitive clauses. No such ordering effect was found for NP conjunctions: Participants were no more likely to recall animate conjuncts preceding inanimate conjuncts than vice versa. (We return to this in the "General discussion".)

Although Experiment 1 provided evidence that animacy can directly influence word order, it did not address whether animacy independently influences grammatical function assignment, as the two alternative structures that were tested had the same grammatical function assignment and differed only in word order. Experiment 2 therefore extended and partly replicated Experiment 1 by manipulating both word order and grammatical function assignment for the transitive sentences, using the same sentence-recall method.

## Experiment 2

In Experiment 2, we examined how people recalled transitive clauses that differed in word order (SOV vs. OSV) and grammatical function assignment (active: agent = subject, patient = direct object vs. passive: patient = subject, agent = oblique object). Based on the results of Experiment 1, we expected participants to show an overall preference for SOV order. More importantly, they should be more likely to recall OSV sentences involving inanimate objects (i.e., inanimate-first OSV sentences) as SOV sentences than to recall OSV sentences involving animate objects (i.e., animate-first OSV sentences) as SOV sentences, irrespective of voice.

If animacy also affects grammatical function assignment, then animacy should affect the voice in which participants recall sentences. Specifically, participants should additionally prefer to recall sentences in a form that allows an animate entity rather than an inanimate entity to appear as the subject, irrespective of word order. Hence we would expect more voice inversions in both inanimate-first SOV sentences and animate-first OSV sentences (where the animate entity is the object) than in animate-first SOV sentences and inanimate-first OSV sentences (where the inanimate entity is the object). In particular, any tendency to recall an animate-first OSV sentence as an inanimate-first OSV sentence (i.e., in the alternative voice) more often than to recall an inanimate-first OSV sentence as an animate-first OSV sentence (i.e., in the alternative voice) cannot be due to a relationship between animacy and word order: In such cases, the effect of voice inversion would be to make the animate entity move from first position in the sentence to second position (e.g., *By fisherman$_{OBJ}$ the boat$_{SUBJ}$ was carried* recalled as *The boat$_{OBJ}$ fisherman$_{SUBJ}$ carried*). Tables 4 and 5 summarize how word order and voice inversions

**Table 4**
Experiment 2: Effect of word order inversion on position and grammatical function of animate entity, by condition.

| | Inversion → animate in first position | Inversion → animate Subject |
|---|---|---|
| An-first SOV active | X | √ |
| An-first SOV passive | X | √ |
| An-first OSV active | X | X |
| An-first OSV passive | X | X |
| In-first SOV active | √ | X |
| In-first SOV passive | √ | X |
| In-first OSV active | √ | √ |
| In-first OSV passive | √ | √ |

**Table 5**
Experiment 2: Effect of voice inversion on position and grammatical function of animate entity, by condition.

| | Inversion → animate in first position | Inversion → animate subject |
|---|---|---|
| An-first SOV active | X | X |
| An-first SOV passive | X | X |
| An-first OSV active | X | √ |
| An-first OSV passive | X | √ |
| In-first SOV active | √ | √ |
| In-first SOV passive | √ | √ |
| In-first OSV active | √ | X |
| In-first OSV passive | √ | X |

affect the position and grammatical function of the animate entity for each condition.

*Method*

*Participants*

Seventy-two further native speakers of Japanese from University of Electro-communication (in Japan) participated for payment. Data from 18 further participants were excluded (see procedure).

*Items*

We used the 42 pairs of animate/inanimate nouns and their associated preambles from Experiment 1, plus the six additional pairs of animate/inanimate nouns and their associated preambles that were pretested for Experiment 1, yielding 48 items. There were no differences in how closely the animate vs. inanimate nouns were associated with the preamble nouns (means: 6.69 vs. 6.78, $t < 1$). The animate and inanimate nouns did not differ in frequency (means: 8116 vs. 11,053, $t < 1$). We constructed 48 items like those in (7–10), each comprising a locative prepositional phrase (the preamble) and a main clause that contained an animate noun and an inanimate noun. Each item had eight versions, each containing the same prepositional phrase, noun phrases, and transitive verb, constructed by crossing animacy of the first noun (animate vs. inanimate) with word order (SOV vs. OVS) with voice (active vs. passive). In addition, we constructed 24 filler sentences containing a locative prepositional phrase, an intransitive verb, and a noun; 12 had an animate agent and 12 had an inanimate agent.

(7a) 港で,漁師がボートを運んだ。(An-first SOV active)
minato de, ryoshi-ga booto-o hakonda.
Harbor in, fisherman-$_{NOM}$ boat-$_{ACC}$ carried-$_{ACT}$
*'In the harbor, the fisherman carried the boat.'*

(7b) 港で,ボートが漁師を運んだ。(In-first SOV active)
minato de, booto-ga ryoshi-o hakonda.
Harbor in, boat-$_{NOM}$ fisherman-$_{ACC}$ carried-$_{ACT}$
*'In the harbor, the boat carried the fisherman.'*

(8a) 港で,漁師をボートが運んだ。(An-first OSV active)
minato de, ryoshi-o booto-ga hakonda.
Harbor in, fisherman-$_{ACC}$ Boat-$_{NOM}$ carried-$_{ACT}$
*'In the harbor, the fisherman, the boat carried.'*

(8b) 港で,ボートを漁師が運んだ。(In-first OSV active)
minato de, booto-o ryoshi-ga hakonda.
Harbor in, boat-$_{ACC}$ fisherman-$_{NOM}$ carried-$_{ACT}$
*'In the harbor, the boat, the fisherman carried.'*

(9a) 港で,漁師がボートによって運ばれた。(An-first SOV passive)
minato de, ryoshi-ga booto-niyotte hakobareta.
Harbor in, fisherman-$_{NOM}$ boat-$_{OBL}$ carried-$_{PAS}$
*'In the harbor, the fisherman was carried by the boat.'*

(9b) 港で,ボートが漁師によって運ばれた。(In-first SOV passive)
Minato de, booto-ga ryoshi-niyotte hakobareta.
Harbor in, boat-$_{NOM}$ fisherman-$_{OBL}$ carried-$_{PAS}$
*'In the harbor, the boat was carried by the fisherman.'*

(10a) 港で,ボートによって漁師が運ばれた。(An-first OSV passive)
Minato de, booto-niyotte ryoshi-ga hakobareta.
Harbor in, boat-$_{OBL}$ fisherman-$_{NOM}$ carried-$_{PAS}$
*'In the harbor, by the boat, the fisherman was carried.'*

(10b) 港で,漁師によってボートが運ばれた。(In-first OSV passive)
minato de, ryoshi-niyotte booto-ga hakobareta.
Harbor in, fisherman-$_{OBL}$ boat-$_{NOM}$ carried-$_{PAS}$
*'In the harbor, by the fisherman, the boat was carried.'*

As in Experiment 1, the items were placed into eight lists, each comprising 72 sentences (48 experimental sentences and 24 filler sentences) and one version of each item. Each

**Table 6**
Experiment 2: The frequency of responses for animacy of first noun, voice, and word order.

| Animacy | Voice | Word order | Recalled responses | | | | |
|---|---|---|---|---|---|---|---|
| | | | Correct | Word order inversion | Voice inversion | Word order + voice inversion | Other |
| Animate | Active | SOV | 232 | 4 | 6 | 2 | 134 |
| | | OSV | 59 | 46 | 82 | 8 | 221 |
| | Passive | SOV | 203 | 21 | 6 | 6 | 142 |
| | | OSV | 118 | 18 | 79 | 1 | 162 |
| Inanimate | Active | SOV | 184 | 3 | 37 | 18 | 136 |
| | | OSV | 83 | 104 | 28 | 8 | 155 |
| | Passive | SOV | 160 | 33 | 17 | 26 | 142 |
| | | OSV | 139 | 49 | 38 | 1 | 151 |

**Table 7**
Model coefficients and probabilities for best-fitting models. The intercept represents the log-odds for the specified response (word order inversion). The "Slope" column indicates whether the random slope parameter corresponding to the effect was included in the model for participants ($p$) or items (i).

| Response | Predictor | Coefficient | Std. error | Wald $Z$ | $p$ (coefficient $\neq 0$) | Slope |
|---|---|---|---|---|---|---|
| Word order inversion | Intercept | 2.02 | 0.16 | -13.9 | <.001 | |
| | Animacy | 0.68 | 0.21 | 3.31 | <.001 | ($p$) |
| | Voice | 0.34 | 0.24 | 1.41 | n.s. | |
| | Word order | −2.44 | 0.24 | −10.2 | <.001 | |
| | Voice * word order | 3.79 | 0.48 | 7.88 | <.001 | |
| Voice order inversion | Intercept | −1.83 | 0.14 | −12.8 | <.001 | |
| | Animacy | 0.30 | 0.19 | 1.52 | n.s. | |
| | Word order | −2.21 | 0.20 | −11.3 | <.001 | |
| | Animacy * word order | 2.95 | 0.39 | 7.57 | <.001 | |

version of an item was seen by nine participants, and each participant saw six items in each condition.

*Procedure*

This was identical to Experiment 1, except that there was one practice block and nine experimental blocks. The experimental session lasted 40 min.

*Scoring*

Participants' responses were scored as in Experiment 1. We carried out separate sets of analyses on word order inversions and voice inversions. We restricted our analyses to word order inversions and voice inversions, and did not consider inversions of both word order and voice (i.e., word order + voice inversions), because they were comparatively rare and because the underlying cause of the two types of inversion (in particular, the order in which they occurred) cannot be determined.[1] We excluded data from six items that could have had alternative interpretations than those intended or were potentially infelicitous. For ease of exposition, we report where relevant percentages of responses in each condition; for word order inversions, these are calculated over the total number of word order inverted and correctly recalled sentences in each condition; for voice inversions, these are calculated over the total number of voice inverted and correctly recalled sentences in each condition.

*Results*

The frequency of responses by Animacy of the first noun, Voice and Word Order are shown in Table 6. For both analyses we ran mixed logit models with Animacy of the first noun, Voice and Word Order (in that order) and all the interactions between them as fixed factors, and participant and items as random effects. Random slope parameters were included in the models using forward selection (Baayen, 2008). The best fit models for both analyses are summarized in Table 7.

*Word order inversions*

For Word Order Inversions, the 3-way interaction was not significant and was removed from the model ($p > .5$). There was a main effect of the Animacy of the first noun; participants recalled more word inversions when the first noun was inanimate (13%) than when it was animate (6%). There was a main effect of Word Order; participants recalled more word order inversions for OSV (15%) than SOV (4%) sentences. There was also an interaction between Voice and Word Order; participants were more likely to recall active OSV sentences than passive OSV sentences as SOV sentences (51% vs. 21%). Simple main effects revealed that there was a main effect of Word Order for Active sentences (log-odds coefficient $B = -4.34$ ($SE = 0.42$), $p < .001$); and for Passive sentences (log-odds coefficient $B = -4.27$ ($SE = 0.42$), $p < .001$). Fig. 2 shows the proportions of word order inversions in Experiment 2.

[1] In fact, Table 6 shows that although there were relatively few responses involving both word order and voice inversion in Experiment 2, such responses were more frequent than in Experiment 1. This is most likely because the experimental sentences in Experiment 2 included both active and passive voice (whereas experimental sentences in Experiment 1 were all active voice), increasing the overall likelihood of participants producing voice inversions, some of which coincided with word order inversions.

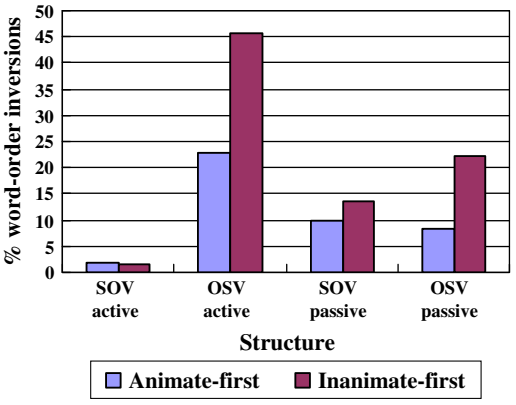


**Fig. 2.** Experiment 2: Percentage of word order inversions on recall by condition.

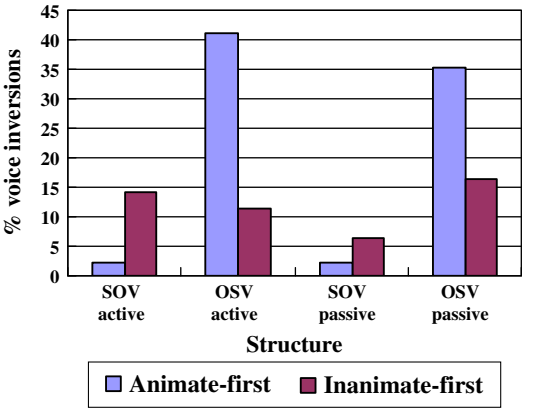


**Fig. 3.** Experiment 2: Percentage of voice inversions on recall by condition.

*Voice inversions*

As stated above, we predicted a tendency for participants to recall sentences in a form that would allow the animate entity to appear as the subject. Participants should therefore be more likely to recall sentences involving animate objects as sentences involving animate subjects, which would arise through inverting the voice of the original sentence (from active to passive, and vice versa), than to recall sentences involving inanimate objects as sentences involving inanimate subjects. In our experimental design, such an effect would manifest itself as an interaction of Animacy of the first noun by Word order (see Table 4).

For Voice Inversions, the main effect of Voice and interactions with Voice were not significant and were removed from the model ($p > .5$). There was a main effect of Word Order; participants were more likely to recall OSV sentences than SOV sentences with the alternative voice to that originally presented (15% vs. 4%). There was also an interaction between Animacy and Word Order; participants were more likely to invert voice when this made an animate object into an animate subject than when it made an inanimate object into an inanimate subject. Hence they were more likely to invert voice in the In-first SOV condition (where the animate entity was originally presented as the object) than in the An-first SOV condition (where the animate entity was originally presented as the subject) (14% vs. 3%); and more likely to invert voice in the An-first OSV condition (where the animate entity was originally presented as the object) than in the In-first OSV condition (where the animate entity was originally presented as the subject) (48% vs. 19%). Simple main effects revealed that there was a main effect of Animacy for SOV sentences (log-odds coefficient $B = -1.18$ ($SE = 0.19$), $p < .001$); and for OSV sentences (log-odds coefficient $B = 1.77$ ($SE = 0.34$), $p < .001$). Fig. 3 shows the proportions of voice inversions in Experiment 2.

*Discussion*

The results of Experiment 2 replicated those of Experiment 1 in demonstrating an overall preference for SOV order. As in Experiment 1, this preference was influenced by animacy: Participants recalled OSV sentences as SOV sentences more often when this resulted in the animate entity appearing first than when it resulted in the inanimate entity appearing first. More importantly, they also showed an effect of animacy upon grammatical function assignment: Participants recalled sentences in the opposite voice to that originally presented (but retained the same word order as originally presented, i.e. SOV or OSV) more often when this resulted in the animate entity appearing as the subject than when it resulted in the inanimate entity appearing as the subject; this effect held for sentences originally presented as SOV actives and passives, and for sentences originally presented as OSV actives and passives. Crucially, participants recalled animate entities as subjects even when this resulted in the animate entities appearing in second position.

## General discussion

In two experiments, Japanese native speakers showed systematic influences of conceptual information on syntactic structure choice. When they recalled transitive sentences, they were more likely to assign animate entities earlier positions in the sentence than inanimate entities (Experiments 1 and 2). They were also more likely to recall animate entities as sentence subjects than inanimate entities (Experiment 2).

Taken together, these results cast light on the nature of syntactic structure choice in sentence production, and specifically the contentious issue of how conceptual factors affect syntactic choice. Existing models of language production have proposed two possible roles for conceptual influences on syntactic choice. One possibility is that conceptual information affects grammatical function assignment only; in such accounts, conceptual information plays no role in determining word order (e.g., Bock & Warren, 1985). Alternative accounts have proposed that conceptual information directly influences choice of word order (e.g., De Smedt, 1990; Kempen & Hoenkamp, 1987); such accounts do not explicitly consider whether it also influences assignment of grammatical functions.

Previous empirical research has found mixed results, with some studies showing effects of conceptual factors

on word order (e.g., Branigan & Feleki, 1999; Kelly et al., 1986; Kempen & Harbusch, 2004), but others showing no such influence (Bock & Warren, 1985; McDonald et al., 1993). Our experiments demonstrate clear effects of one type of conceptual factor, namely animacy, on the order of constituents in Japanese transitive sentences. But in addition, Experiment 2 showed that it also affected the assignment of grammatical functions in such sentences, independent of word order. Hence, conceptual information influenced both the way in which grammatical functions were assigned and choice of word order. However, it did not affect the order of conjuncts in NP conjunctions.

Our pattern of effects converges with recent research by Chang (2009), who reported simulations of Japanese production using an error-based learning connectionist model based on Chang, Dell, and Bock (2006). His model also produced output in which animate entities tended to precede inanimate entities in SOV transitive sentences, but not in conjunctions. We now consider how to interpret these results in terms of models of sentence production.

### *Word order and grammatical function assignment in models of production*

Our data allow us to discriminate among potential accounts of conceptual accessibility effects on syntactic choice. First, they are incompatible with a strong version of a grammatical function account, in which speakers first map concepts to grammatical functions according to Keenan and Comrie's (1977) accessibility hierarchy. On this account, the first-accessed concept is assigned to the subject function, the second-accessed concept is assigned to the object function, and so on; and grammatical functions are then mapped to word order (Bock & Warren, 1985). Because animate concepts are highly predicable and hence more likely to be accessed first, animate entities are likely to become subjects. Grammatical functions are then mapped to specific word order positions, depending on the constraints of the language. This account explains the tendency for animate entities to come first in English transitive sentences (where subjects almost always appear first) and does not predict that they will tend to come first in conjuncts. It can therefore explain the association between animacy and subjecthood in Japanese transitive sentences that we found in Experiment 2.

However, this account cannot explain our finding that animate entities tend to come first irrespective of grammatical function. In fact the account is incompatible with the widely held assumption that word order variations promote fluency by allowing easily accessible material to be placed in early word order positions irrespective of grammatical function (e.g., Levelt, 1989). For example, it would mean that a Japanese speaker who decided to say *ryoshi-o booto-ga hakonda* ('Fisherman-$_{OBJ}$ the boat-$_{SUBJ}$ carried') would retrieve the concepts and lemmas associated with *fisherman* first, but would then have to buffer them until retrieving and assigning the subject function to *boat*; she would then have to buffer *boat* until *fisherman* had been assigned the direct object function and placed in first position. Our data support the assumption that word order variations promote fluency; they rule out any account in which conceptual accessibility effects manifest themselves only in the assignment of grammatical functions.

Our data are also incompatible with one strong version of a word order account (which has not been proposed, to our knowledge), in which speakers always map concepts to word-order positions before assigning them grammatical functions: Such an account could not explain the tendency for animate entities to become subjects, independent of word order (Experiment 2). But our findings are also incompatible with De Smedt's (1990) parallel account, under which conceptual accessibility simultaneously affects a single stage of grammatical function and word order assignment. Sometimes speakers assign grammatical function first (in which case they must then choose a compatible word order), and sometimes speakers assign word order first (in which case they must then choose a compatible grammatical function assignment). On those occasions when word order is assigned first, the more accessible entity should be assigned first position. In other words, De Smedt's account predicts that more accessible entities should tend to come first in conjuncts. In fact, there should be a similar effect of conceptual accessibility on word order when the two noun phrases have the same grammatical function and when they have different grammatical functions. But this is not what Experiment 1 found.

We now outline an alternative account that is compatible with our findings and with other recent proposals (e.g., Onishi et al., 2008; see also Bock, Irwin, & Davidson, 2004; Bock, Irwin, Davidson, & Levelt, 2003), in which syntactic processing fundamentally reflects the ease with which speakers can integrate conceptual elements to form a message. On this account, the processor maps concepts to grammatical functions, before mapping these function assignments to specific word orders, and in so doing considers multiple possible mappings. Conceptual accessibility directly affects the process of grammatical function assignment, and indirectly affects the process of word order determination. This account therefore combines elements of both Bock and Warren's (1985; see also Bock, 1987) and Kempen and Hoenkamp's (1987) models. It assumes that both concepts and grammatical functions differ in their accessibility during language production. During an initial stage of conceptualization, when the speaker is determining the message to be expressed, some concepts (e.g., animate entities) are more accessible than others because they are more predicable: That is, speakers can more easily integrate those elements with a predicate to form a message. Such concepts therefore tend to become activated and therefore available for grammatical function assignment before concepts that are less predicable. Additionally, higher grammatical functions (in particular, subjects) tend to be activated before lower grammatical functions, reflecting the fact that conceptual prominence within a message tends to be associated with higher grammatical functions. Note that conceptual accessibility is defined in terms of predicability; thus conceptual dimensions that are not associated with variations in predicability (e.g., differences in category typicality, where typical and atypical exemplars of a given category are equally predicable) do not give rise to differences in grammatical function assignment (Onishi et al., 2008).

Assuming binding-by-timing (i.e., elements that are activated at roughly the same time tend to become associated), more predicable concepts tend to be associated more strongly with higher grammatical functions, and less predicable concepts tend to be associated more strongly with lower grammatical functions. However, different sets of assignments can be considered in parallel as they become available (Bock, 1987). We further assume that function assignment occurs incrementally, as and when each relevant function and concept reaches criterial activation.

Let us consider how a speaker might encode the message that a boat carried a fisherman in this model. We assume that two possible sets of function assignments are activated and considered in parallel for selection: In the first, the concept FISHERMAN is assigned to subject and BOAT to object; in the second, FISHERMAN is assigned to object and BOAT to subject. Because of the greater accessibility of the animate concept and the subject function, the first function assignment that is likely to be achieved (because both the relevant function and the relevant concept reach sufficient activation) is that of FISHERMAN to the subject function. In contrast, when encoding the message that a boat and a fisherman were moving, the model only considers possible functional assignments in which the two concepts are assigned the same function, for example when BOAT is assigned subject function and FISHERMAN is also assigned subject function. (Of course there are circumstances where the processor might consider alternative pairs of function assignments for conjuncts, as in *The fisherman and the boat surprised the man* vs. *The man was surprised by the fisherman and the boat*. Crucially, however, both conjuncts receive the same function as each other under either assignment).

These grammatical function assignments are then mapped to word order. At this point, earlier positions tend to be activated before later positions (presumably to preserve incrementality and reduce buffering). Because higher functions tend to be assigned earlier than lower functions, they therefore tend to be bound to earlier positions. Thus, when different concepts are bound to different grammatical functions, more accessible concepts tend to be bound to earlier positions than less accessible concepts. But when different concepts are bound to the same grammatical function (as in NP conjunctions), such a tendency does not occur. Hence the account predicts that animacy (or conceptual accessibility more generally) does not systematically affect word order in conjunctions. Instead, word order in conjunctions may be determined by factors that do not affect predicability (and hence do not affect function assignment) but do affect the relative accessibility of lexical representations; they may include conceptual dimensions such as typicality (Onishi et al., 2008).

The preference for higher grammatical functions to be activated before lower grammatical functions, and for early word order positions to be activated before later word order positions, explain the cross-linguistic tendency for subjects to precede objects in typologically diverse languages (Comrie, 1989). But critically, they also explain why conceptually accessible entities are likely to appear as sentence-initial subjects. Note however that such tendencies are not absolute. For example, as Bock (1987) pointed out, the general preference for active structures over passive structures means that grammatical functions associated with passive verb forms may have lower activation than grammatical functions associated with active verb forms. This means that on some occasions a concept may be assigned the direct object function associated with an active verb form more quickly than it may be assigned the subject function associated with a passive verb form. If the grammatical rules of the language allow, this direct object may then be bound to an early word order position, resulting in production of an OS order. Thus syntactic processing can exploit the availability of alternative word orders to promote fluency (see Ferreira, 1996).

This account straightforwardly explains why conceptually accessible entities may appear in early word order positions even when they do not bear the subject function: Because they are more predicable, they undergo grammatical function assignment earlier than less conceptually accessible entities, but do not always claim the subject function during this process; and they subsequently undergo positional processing earlier than less accessible concepts. As a result, they tend to be assigned an early word position despite not bearing the subject function.

Of course, different word orders themselves may have different levels of accessibility, so that OS orders may be chosen less frequently than SO orders, in keeping with the general cross-linguistic preference for subjects to precede objects, and the specific preference in Japanese for canonical SOV order over OSV order. Consistent with this, in Experiment 1 animacy affected word order in SOV responses (i.e., participants were more likely to recall sentences originally presented as OSV sentences as SOV sentences when the subject was animate than when it was not) but did not reliably affect OSV responses, and similarly in Experiment 2 effects of animacy on word order were stronger in SOV responses than in OSV responses. Thus influences of conceptual accessibility at the functional level may be overridden by effects of favored vs. disfavored word orders during a later stage of processing. (See Ferreira & Yoshita, 2003, for further evidence that conceptual factors – in their study, givenness – and canonicality of word order may both affect grammatical encoding.)

In this account, then, the syntactic choices that speakers make are ultimately determined by a complex interplay of factors of which the accessibility of different concepts, as determined by their predicability, is only one. Conceptual accessibility directly affects the order in which concepts become available to participate in grammatical function assignment. It is associated with subjecthood because the subject function tends to be assigned first; and it is associated with early word order positions because the concept that is retrieved first tends to be assigned a grammatical function first, the first grammatical function to be assigned tends to undergo positional processing first, and the first element to undergo positional processing tends to be assigned the earliest word order position. In NP conjunctions, however, the same grammatical function is assigned twice (to different concepts) and so there is no reason why one of these assignments should systematically undergo positional processing before the other. Instead, word order in NP conjunctions may be based on other factors such as lexical accessibility (Onishi et al., 2008).

In conclusion, our experiments elucidate the relationship between conceptual factors and linguistic form. When people recalled transitive Japanese sentences, they were more likely to assign animate entities earlier positions in the sentence than inanimate entities. In addition, they were more likely to recall animate entities than inanimate entities as sentence subjects in active and passive sentences. Thus conceptual information that affected the ease with which speakers could integrate elements into a meaningful message influenced both the way in which grammatical functions were assigned and choice of word order.

## A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at doi:1.1016/j.jml.2011.04.009.

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