Cognition 118 (2011) 377–397

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Hierarchy and scope of planning in subject–verb agreement production

Maureen Gillespie [1], Neal J. Pearlmutter *

Psychology Dept., 125 NI, Northeastern University, Boston, MA 02115, United States

ARTICLE INFO

Article history:
Received 29 December 2009
Revised 5 October 2010
Accepted 8 October 2010
Available online 27 November 2010

Keywords:
Sentence production
Number agreement
Syntactic planning
Semantic integration
Hierarchical feature-passing
Scope of planning
Speech errors
Subject–verb agreement

ABSTRACT

Two subject–verb agreement error elicitation studies tested the hierarchical feature-passing account of agreement computation in production and three timing-based alternatives: linear distance to the head noun, semantic integration, and a combined effect of both (a scope of planning account). In Experiment 1, participants completed subject noun phrase (NP) stimuli consisting of a head NP followed by two prepositional phrase (PP) modifiers, where the first PP modified the first NP, and the second PP modified one of the two preceding NPs. Semantic integration between the head noun and the local noun within each PP was held constant across structures. The mismatch error pattern showed an effect of linear distance to the head noun and no influence of hierarchical distance. In Experiment 2, participants completed NP PP PP stimuli in which both PPs modified the head noun, and both the order of the two PPs and the local nouns' degree of semantic integration with the head noun were varied. The pattern of mismatch errors reflected a combination of semantic integration and linear distance to the head noun. These studies indicate that agreement processes are strongly constrained by grammatical-level scope of planning, with local nouns planned closer to the head having a greater chance of interfering with agreement computation.

1. Introduction

The study of language production is concerned with how speakers translate non-verbal thoughts into meaningful grammatical utterances. While this is a fairly effortless task that requires little conscious consideration on behalf of the speaker, the nature of the processes that underlie this task are complex. Most language production models (e.g., Bock & Levelt, 1994) separate the production planning process into three main levels: the message level, which represents the speaker's intended meaning; the grammatical encoding level, which translates the meaning into a sequence of words; and the phonological encoding level, which translates the sequence of words into the articulatory plan required to produce the utterance. The current work focuses on the grammatical encoding process and specifically on syntactic planning, which is responsible for creating a syntactic structure encoding word order, hierarchical syntactic relations, and inflections.

Inflectional processes in particular have been investigated in a variety of studies, typically by examining the conditions under which subject–verb agreement errors can be elicited, as a way of gaining insight into syntactic plannin (e.g., Bock & Cutting, 1992; Bock & Miller, 1991; Franck, Vigliocco, & Nicol, 2002, 2006; Hartsuiker, Antón-Méndez, & van Zee, 2001; Solomon & Pearlmutter, 2004b; Vigliocco & Nicol, 1994, 1998). Bock and Miller (1991) conducted the first study that elicited subject–verb agreement errors in a laboratory setting. They used sentence preambles that were composed of a head noun followed by a phrase containing a local noun (e.g., as in (1)). Subject–verb agreement errors are commonly produced in sentences containing subject noun phrases with this structure when the head and local noun mismatch in number. Experimental items in Bock and Miller's study

* Corresponding author. Tel.: +1 617 373 3040; fax: +1 617 373 8714.
E-mail addresses: gillespie.m@neu.edu (M. Gillespie), pearlmutter@neu.edu (N.J. Pearlmutter).
[1] Tel.: +1 617 373 3798.

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doi:10.1016/j.cognition.2010.10.008

manipulated the number marking of the head and local nouns to form four number conditions. Conditions in which the head noun (*key*) and local noun (*cabinet*) had different number markings ((1b), containing the singular–plural (SP) sequence, and (1c), containing the plural–singular (PS) sequence) were considered the mismatch conditions, while conditions in which the head noun and local noun had the same number marking (1a and 1d) were considered the match conditions. Preambles were presented auditorily, and participants were required to repeat them and then complete them as full sentences.

(1) a. (SS) The key to the cabinet
b. (SP) The key to the cabinets
c. (PS) The keys to the cabinet
d. (PP) The keys to the cabinets

Nearly all agreement errors occurred in the mismatch conditions (1b and 1c). Within these conditions, agreement errors were more common when the head noun was singular and the local noun was plural (1b) than when the head noun was plural and the local noun was singular (1c). This error pattern is referred to as the mismatch effect and has been replicated in essentially all studies examining subject–verb agreement (e.g., Bock & Cutting, 1992; Bock & Eberhard, 1993; Bock, Eberhard, Cutting, Meyer, & Schriefers, 2001; Bock & Miller, 1991; Bock, Nicol, & Cutting, 1999; Eberhard, 1999; Franck, Lassi, Frauenfelder, & Rizzi, 2006; Hartsuiker et al., 2001; Negro, Chanquoy, Fayol, & Louis-Sidney, 2005). The interference of plural local nouns, and relative lack of interference of singular local nouns, on subject–verb agreement provides support for the hypothesis that plural noun forms are marked with a plural feature, while singular nouns are unmarked (Berent, Pinker, Tzelgov, Bibi, & Goldfarb, 2005; Bock & Eberhard, 1993; Bock & Miller, 1991; Eberhard, 1997; Eberhard, Cutting, & Bock, 2005; Vigliocco & Nicol, 1994, 1998). While this latter pattern, the plural markedness effect, does not provide evidence for a specific mechanism for agreement effects, it does show that mismatch effects are not simply a result of agreement with the nearest noun and that a more complex mechanism is involved.

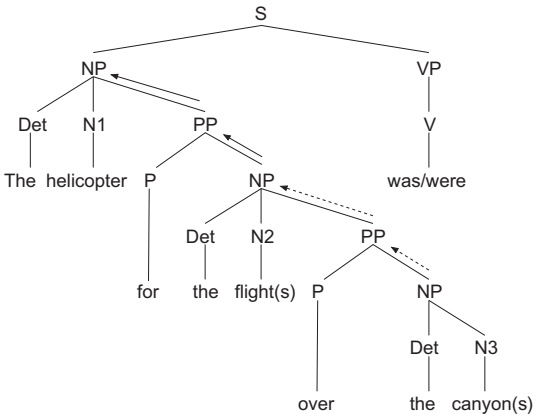

Fig. 1. Syntactic path a plural feature must travel to interfere with agreement in Franck et al.'s (2002) stimuli. The route for a feature from N2 is shown with solid arrows; the route for a feature from N3 includes the route from N2 as well as the dashed arrows, so additional feature-passing errors would have to occur before N3's plural feature could influence verb number, predicting fewer subject–verb agreement errors when N3 is plural compared to when N2 is.

Most production research assumes that agreement is implemented through hierarchical feature-passing (Eberhard et al., 2005; Franck et al., 2002; Hartsuiker et al., 2001; Vigliocco & Hartsuiker, 2002; Vigliocco & Nicol, 1998). According to this view, agreement is computed once the syntactic tree structure of a sentence is formed, with number features being passed up through the subject NP to the verb phrase. Mismatch effects occur when a plural feature is inadvertently passed too far up the tree, overwriting the number from the head noun with the number from a local noun. Franck et al. (2002) provide the most direct test of the hierarchical feature-passing hypothesis in an error elicitation experiment using subject NP preambles containing two PP modifiers, as in (2). Their stimuli had a descending hierarchical structure in which each PP modified the immediately preceding noun, and the local nouns (*flight* and *canyon* in (2)) varied in number. Fig. 1 shows the syntactic structure as well as the path along which an errant feature from N2 or N3 would have to pass.

(2) a. (SSS) The helicopter for the flight over the canyon
b. (SPS) The helicopter for the flights over the canyon
c. (SSP) The helicopter for the flight over the canyons
d. (SPP) The helicopter for the flights over the canyons

The hierarchical feature-passing hypothesis predicts a larger mismatch effect for preambles like (2b) than for preambles like (2c). Because N2 (*flight(s)*) is hierarchically closer to the verb than N3 (*canyon(s)*) is, fewer feature-passing errors would have to occur for N2's plural to interfere with agreement in (2b) than for N3's plural to interfere in (2c). Franck et al. (2002) found that the N2 mismatch effect was larger than the N3 mismatch effect in both English and French, and they thus argued for a hierarchical feature-passing account of subject–verb agreement over a linear account in which interference increases with (linear) proximity to the verb.

Current models of agreement computation also assume mechanisms that are consistent with a hierarchical feature-passing account (Eberhard et al., 2005; Vigliocco & Hartsuiker, 2002). Eberhard et al.'s Marking and Morphing model was implemented to account for the findings of a number of agreement studies. According to this model, the marking process assigns number to the subject NP as a whole based on message-level properties. Separately, each noun within the subject NP is also assigned a number specification from its lexical entry, and morphing then combines the subject NP number value set by marking with the number values from all the nouns within the subject NP, to yield an overall specification of number for the subject. This specification in turn determines the probability of singular versus plural agreement on the verb. The morphing process encodes the hierarchical distance assumption: Nouns situated further from the subject NP node in the syntactic tree are stipulated to have a weaker influence on the subject NP's number assignment than