Grammatical Subjects in home sign: Abstract linguistic structure in adult primary gesture systems without linguistic input

Marie Coppola* and Elissa L. Newport†‡

*University of Chicago, Chicago, IL 60637; and †University of Rochester, Rochester, NY 14627

Language ordinarily emerges in young children as a consequence of both linguistic experience (for example, exposure to a spoken or signed language) and innate abilities (for example, the ability to acquire certain types of language patterns). One way to discern which aspects of language acquisition are controlled by experience and which arise from innate factors is to remove or manipulate linguistic input. However, experimental manipulations that involve depriving a child of language input are impossible. The present work examines the communication systems resulting from natural situations of language deprivation and thus explores the inherent tendency of humans to build communication systems of particular kinds, without any conventional linguistic input. We examined the gesture systems that three isolated deaf Nicaraguans (ages 14–23 years) have developed for use with their hearing families. These deaf individuals have had no contact with any conventional language, spoken or signed. To communicate with their families, they have each developed a gestural communication system within the home called ''home sign.'' Our analysis focused on whether these systems show evidence of the grammatical category of Subject. Subjects are widely considered to be universal to human languages. Using specially designed elicitation tasks, we show that home signers also demonstrate the universal characteristics of Subjects in their gesture productions, despite the fact that their communicative systems have developed without exposure to a conventional language. These findings indicate that abstract linguistic structure, particularly the grammatical category of Subject, can emerge in the gestural modality without linguistic input.

language | language acquisition | sign language | syntax

Although languages around the world seem highly diverse, all human languages exhibit a number of common properties and are built around similar organizational principles (1, 2). What gives rise to these common properties and principles? In the ordinary case, language and its grammatical properties arise from the combined influences of the linguistic environment (e.g., overheard French or Tagalog) and the tendencies of humans to communicate in particular ways. An important question concerns how to distinguish environmental contributions from these inherent human tendencies. One approach is to see whether any of the same linguistic properties appear in unusual communication systems known as ''home sign'' systems, which are developed without normal linguistic input. Some profoundly deaf children who are otherwise healthy are raised in hearing families in which no one knows a sign language. These children's profound hearing losses prevent them from acquiring a spoken language naturally. At the same time, they are not exposed to, and thus do not acquire, a sign language. Deaf children who grow up in such circumstances will nonetheless gesture with their family and friends, creating idiosyncratic gestural communication systems called home sign (3–5). These young children's home sign systems have been shown to possess many simple aspects of semantic and grammatical structure, even without linguistic input; but other, more abstract properties of linguistic systems have not been observed.

In previous studies, it has not been possible to ask whether these abstract linguistic properties would emerge, without input, in more mature individuals. In the United States and many other countries, deaf children attend school and are exposed to conventional spoken or signed languages by age 5 or earlier. However, there are circumstances in other parts of the world where deaf individuals may continue using their home sign systems into adulthood, with no exposure to a sign language (and often with no contact with other deaf people). The present report examines the linguistic properties of mature home sign systems as used by these very rare deaf adults who have used their home sign systems all their lives and who have had no other access to language. Study of these home sign systems allows us to ask whether more abstract grammatical properties of linguistic systems can emerge in more mature and experienced users, or rather whether additional generations of language use or linguistic input are required before such properties appear.§ Our focus is on the abstract category of grammatical Subject. Study 1 asks whether adult home signers spontaneously and naturally demonstrate the universal characteristics of grammatical Subject in their gesture productions. Study 2 asks whether the regularities exhibited in Study 1 could be attributed to a pragmatic notion such as Topic rather than to the syntactic notion of Subject.

What Is a Subject?

Language imperfectly and arbitrarily maps concepts to symbols. Although some concepts are highly correlated with grammatical structures, exceptions abound (7). For example, although verbs tend to refer to actions, many do not (e.g., think); similarly, although nouns tend to denote objects, this tendency is not absolute (e.g., liberty). Indeed, such mismatches between structure and meaning are a hallmark of language.

A prominent example of this abstract property of linguistic structure is the notion of grammatical Subject. Grammatical Subjects are widely considered to be universal to human languages, appearing in similar formats across languages around the globe. Subjects do not have a simple semantic correlate. Although the subject of a sentence often corresponds to the role of Agent (one who intentionally performs an action), not all Subjects are Agents. Each of the underlined noun phrases in the following English sentences is the Subject, even though none takes the same semantic or thematic role (indicated in parentheses): John opened the door (Agent); The door opened

PSYCHOLOGY

(Theme or Patient); <u>The key</u> opened the door (Instrument); <u>The wind</u> opened the door (Instigator).

No fixed criteria exist to categorically identify a noun phrase as a Subject, but a set of common, multidimensional criteria can be applied across languages (8). For example, Subjects: (*i*) occupy a characteristic position in the basic word order or show characteristic distribution or absence; (*ii*) control verb agreement; (*iii*) carry overt subject case-marking in languages that mark case; and (*iv*) express the Agent of the action (if there is one). As is the case in English, Subject noun phrases cross-linguistically display a range of semantic roles: although the Subject of a sentence may be an Agent, many other semantic roles can be the Subject, including Experiencer, Patient, and Theme. Implicit in the above criteria and important for the present studies is the lack of a semantically constant value associated with Subjects (9–12).

Acquisition of Grammatical Categories

How much of the architecture of human linguistic systems, including these basic and somewhat arbitrary grammatical categories, results from innate human predispositions to organize communicative signals in particular ways? Some researchers attribute the widespread appearance of Subjects to a special language faculty, or to "universal grammar" (1, 2), whereas others attribute this widespread appearance to more general cognitive abilities. Many theories in the latter category suggest that the semantic properties of Agents may underlie children's initial acquisition of the category of Subject; over time, linguistic experience may prompt the child to reorganize Agents into the adult category of Subject (13, 14).

However, the question of whether children begin with the category Subject, or only the concept of Agent, has been difficult to answer by examining early child speech (although see refs. 15 and 16 for experiments with older children). Although the linguistics literature provides many criteria for Subjecthood, only a few are relevant for simple, emerging languages such as child language (or home sign systems). Children's sentences are not complex enough to apply most linguistic diagnostics. Some researchers nonetheless attribute such formal categories (Noun, Verb, Subject) to children's productions (17); others question whether these assignments are justified by the distributional evidence available in children's utterances (18). Although semantic categories such as Agent might provide a starting point, acquisition ultimately requires mastering the formal distributional properties that characterize grammatical categories in all languages (7).

Home Sign

Could a grammatical category such as Subject appear in a communication system developed without linguistic input? Or does it arise only in communicative systems that have been nurtured by many input sources across multiple generations of speaker communities? One way to address this question is to observe whether Subjects appear in the unusual communication systems known as home sign systems. As we have described above, home sign is the gestural communication that often arises spontaneously when a profoundly deaf child grows up within a hearing family where none of the family members knows a conventional sign language (3–5). When the deaf child does not hear well enough to learn speech and is not exposed to a sign language, the child will begin to gesture with family and friends. A number of researchers, but most especially Goldin-Meadow and her colleagues (5), have shown that home sign emerges predominantly from the deaf child, not the parents (who generally continue to speak to the child and produce only limited gesture), and that, even without linguistic input, the deaf child can develop a structured gestural communication system.

By analyzing young home signers' spontaneous gesturing, Goldin-Meadow has found evidence for some linguistic structure at several levels of analysis (morphological, syntactic, discourse) (5, 19–21). Most relevant to the present study, young deaf children distinguish nouns and verbs in their gesturing, and they exhibit a simple syntax in which the probability of producing a gesture for a particular semantic role, and the order of the gesture within the utterance, probabilistically distinguish semantic roles such as Agent and Patient.[¶] Coppola *et al.*[‖] studied three deaf adult home signers in Nicaragua who have used such a gesture system all their lives and who have no other language. They showed that, after using home sign for many years, these adults mark such contrasts even more consistently, using both word order and spatial devices systematically to distinguish Agents from Patients.[**] Similar findings have been reported for young sign languages that have been used for several generations (23–25).

However, as described earlier, the notion of Subject in well developed languages goes beyond the semantic contrast between Agent and Patient and includes non-Agentive semantic roles and abstract, nonphysical events. Do home signers display evidence of Subject, or are home sign systems limited to contrasting semantic roles such as Agent and Patient? Not surprisingly, given the difficulty of asking this question in typical language acquisition situations, this question has not been asked of deaf children's home sign systems. Moreover, not enough is known about the grammatical structure of mature home sign systems to apply the more sophisticated diagnostic tests for Subjecthood, such as examining verb agreement or noun-phrase movement. However, the most central characteristic of Subjects can be examined: their occurrence within the basic word order of sentences, without a semantically constant value.

In the present work, we will seek evidence for grammatically similar treatment of noun phrases bearing very different semantic roles, such as Agents vs. non-Agents. In Study 1, we asked whether home signers showed evidence of marking grammatical Subjects in their gesture systems by examining how they described events involving relationships between people and objects taking different types of semantic roles. Thus, Study 1 explored whether the grammatical devices produced by adult home signers go beyond semantic contrasts to mark the grammatical category of Subject.

Study 1: Grammatical Subjects in Home Sign

Methods. *Participants.* The treatment of participants and all experiments were executed in full compliance with the guidelines set forth by the Research Subjects Review Board of the University of Rochester. Three Nicaraguan home signers (ages 14, 18, and 23 years) participated. The present study is part of a longitudinal project (1996–2004) examining the structure and use of their home sign systems. When these data were collected, the participants did not know or interact with each other. They are all congenitally and profoundly deaf and have not acquired either a spoken language (because of their deafness) or a conventional community sign language (because of their lack of exposure to one). Their production and comprehension of Spanish is extremely limited: they rarely vocalize and produce only a few common Spanish words (e.g., mamá and papá). The home signers have had very little or no formal education and have not received hearing aids or oral instruction; thus, they do

---

[¶]Specifically, they gesture Patients before Acts (e.g., producing GRAPE EAT to express eating a grape). In contrast, Agents tend not to be gestured in transitive events.

[‖]Coppola, M., Senghas, A., Newport, E. L. & Supalla, T., 22nd Boston University Conference on Language Development, Nov. 7–9, 1997, Boston.

[**]However, see Morford and Kegl (22) for another view.

Coppola and Newport

Table 1. Examples of Study 1 test items

One-argument events (24)		Two-argument events (42)	
Type	Examples	Type	Examples
Agent (4)	**Woman** runs	**Agent** (20)	**Man** kisses woman
Non-Agent (20)	**Man** is happy	**Non-Agent** (22)	**Woman** drops ball
	Woman falls		**Woman** sees man
	Rug flaps		**Man** smells flowers

Primary arguments are in boldface. Numbers of events are in parentheses.

not comprehend even very common Spanish words (e.g., tortilla), and they cannot read. They show no apparent cognitive deficits.

It is important to distinguish the home signers in the present study from signers of Nicaraguan Sign Language (NSL), the language of the deaf community in Managua, the capital, that has been developing since the late 1970s (24, 26, 27). None of the home signers knows NSL; they communicate using only a gesture system developed within their families, with no influence from NSL or any other sign language.[††] Their hearing family members gesture with them to varying degrees. Each home signer has at least one person (a parent, sibling, or friend) who is fairly fluent in his gesture system and with whom he gestures regularly. All three participants have been using their home sign systems as their primary means of communication for their entire lives.

Stimuli. The stimuli were 66 videotaped events, each lasting 2–4 s. The events varied in the number of participants involved and in the type and role of the participants in relation to one another; the events were designed to elicit utterances expressing relationships between different types of arguments or semantic roles so that we might examine whether the signers expressed these arguments or roles in consistent ways. The 66 events comprised 24 one-argument events (events consisting of an action involving only one person or object) and 42 two-argument events (events consisting of an interaction between a person and an object or another person). Within each group, we varied the arguments' semantic roles (Agent vs. non-Agent) and animacy (human or inanimate). An Agent was defined as an animate (in this case, human) entity that intentionally performs an action. Non-Agent argument types included Experiencer (person experiencing an emotional state), Patient (person being acted on or manipulated), and Theme (inanimate object). Table 1 provides a schematic of the study design and example items.

One argument in each item was designated the primary argument. In one-argument items, the primary argument was the only argument in the event. Two-argument events contained one primary and one secondary argument, following Jackendoff's cross-linguistic hierarchy for semantic roles and their combinations (12): Given a particular combination of semantic roles in an event (e.g., an Agent and a Patient), one of the arguments (the Agent, in this example) will tend cross-linguistically to become the Subject. If home signers have the grammatical category of
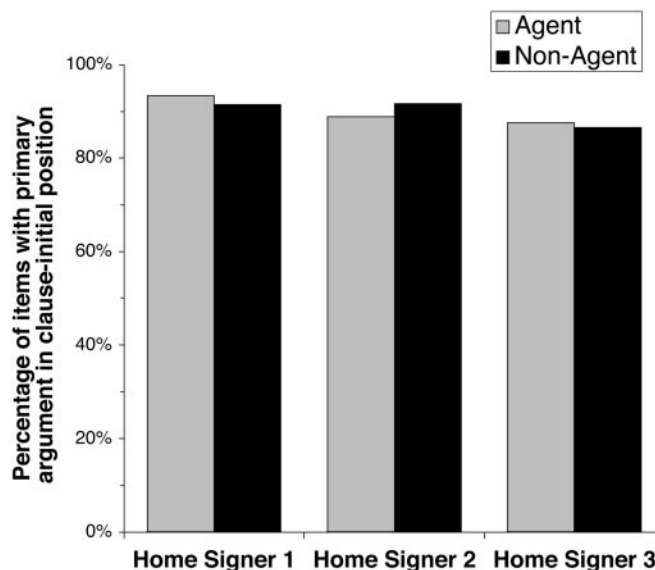
Fig. 1. Study 1: Percentage of items in which the noun phrase referring to the primary argument, Agent or non-Agent, was in clause-initial position.

Subject, their responses should treat primary arguments as grammatical Subjects in accordance with this hierarchy.

Procedure. Each participant viewed the videotaped events, one at a time, and described the event to a communicative partner. To maximize participants' use of their natural gesture system, the communicative partner for each participant was one of his main communication partners in everyday life: his mother, sibling, or a friend who gestures frequently with him. To encourage participants to describe the whole event, rather than merely to name an object or the action, the partner was given an array of four pictures for each event and was asked to choose the picture corresponding to the home signer's gestured description. All gestures were videotaped and transcribed. Details of response coding and analysis are found in *Supporting Materials and Methods*, which is published as supporting information on the PNAS web site.

Results. One possible outcome was that the grammatical devices in young languages might be limited to consistently marking Agents of physical actions, and only with a longer history (or more input) extend these devices to other semantic roles within more abstract event types. In this case, Agent noun phrases in home sign systems might show one pattern, and non-Agent noun phrases might show a different or less consistent pattern. Alternatively, home signers might mark Agent and non-Agent noun phrases in the same way, providing evidence for the grammatical category of Subject. The home signers' responses provided robust support for the second hypothesis. Fig. 1 shows that, for all three home signers, virtually all of the Agent noun phrases were produced in clause-initial position, and the same word order position was also used for non-Agent noun phrases that were the primary arguments of their events. Each home signer thus used the same grammatical device (clause-initial position) to mark Agent and non-Agent noun phrases in their gestured responses.

Study 2: Subject Versus Topic in Home Sign

Despite the strong results of Study 1, we considered the possibility that these word order regularities were not evidence for a notion such as Subject and instead reflect a pragmatic or information structure notion, such as contrasting old or known

Table 2. Examples of Study 2 test items

Vignette	Event type	Character 1	Character 2	Subevent
1	Setup	Woman (Subject/Topic)		Woman is hot
		Woman		Woman takes off her sweater
	Test	Woman (Topic)	**Man** (Subject)	**Man** gives the woman a fan
2	Setup	Woman (Subject/Topic)		Woman arranges flowers
	Test	Woman (Topic)	**Man** (Subject)	**Man** kisses the woman

Primary arguments of Test events are in boldface.

information with new information (28). Study 2 attempted to distinguish these possibilities.

Methods. *Participants.* The same three home signers from Study 1 also participated in Study 2.

Stimuli. The stimuli were 14 videotaped vignettes, each consisting of a sequence of two or three related subevents. These 14 items included two practice vignettes, four filler vignettes, and eight test vignettes. The average length of each item was 10 s (range 5–18 s), and each subevent within the sequence was set off by a very brief fade-in and fade-out. In practice and filler vignettes, the same character performed different actions (e.g., a woman washes a vase and then puts flowers in the vase) throughout the vignette.

In the test vignettes, the primary argument changed over the course of the vignette. This change allowed us to contrast the roles of Subject and Topic across two characters (see Table 2 for examples). The first subevent introduces Character 1 as the primary argument (that is, intended to be treated as a Subject). This event was called the Set-up event. Character 1 in the Set-up event was sometimes an Agent, sometimes a non-Agent. In three-event vignettes, one more subevent shows Character 1 as the primary argument (again, half the time as an Agent, half the time as a non-Agent). However, in the last subevent (called the Test event), Character 2 is introduced and performs an action with respect to Character 1. For this last subevent, then, Character 1 is "old information" (and thus should be the Topic), but Character 2 instigates the action (and thus should be the Subject).[‡‡]

The analyses determined whether the grammatical device used to mark Character 1 in the Setup event was also used to mark the new actor (Character 2) in the final Test event or if the device was used to mark Character 1 in the final Test event. Character 1 in the Setup event is both a Subject and a Topic; the device used to mark this character could therefore be marking either Subjects or Topics. Similar treatment of Character 2 (the new actor) in the Test event would indicate that this device marks Subjects. In contrast, similar treatment of Character 1 (old information) in the Test event would suggest that the device marks Topics. Analyses compared the order of the noun phrases referring to Characters 1 and 2, as well as their spatial marking, in participants' responses.

Procedure. Each participant viewed the videotaped vignettes, one at a time, and described the vignette to a communicative partner. The practice items were presented first and served to train participants to view all of the subevents before responding. As in Study 1, to maximize participants' use of their natural gesture system, the communicative partner for each participant was one of his main communication partners in everyday life: his mother or a sibling. After viewing each vignette, the participant was asked to describe the series of events to his or her communicative partner. Participants could watch the vignette as often as they

liked. All gestures were videotaped and transcribed. Details of response coding and analysis are found in *Supporting Materials and Methods*.

Results. All three home signers consistently placed the primary argument in clause-initial position in both Set-up and Test events. Fig. 2 shows the data for the Test events. As these data show, each home signer used clause-initial position for the primary argument in 100% of the test items. That is, the same device used to mark the primary argument in the Set-up events (Character 1) was used in the Test event to mark the new Character 2 who initiated that event, and not Character 1, who was the old information. Thus, all three participants used structures that marked arguments as Subjects rather than as Topics.

Discussion

Along with other research (5), these findings suggest that certain fundamental characteristics of human language systems appear in gestural communication, even when the user has never been exposed to linguistic input and has not descended from previous generations of skilled communicative partners. The present research examined a particular hallmark of grammatical systems, the Subject. Home signers mark grammatical Subjects in their gestured sentences across a range of events and semantic relations. The notion Subject therefore does not appear to require either linguistic input or a lengthy history within a language to develop.

Of course, many properties of language do emerge more slowly over time, both developmental and historical. Ongoing research on the formation of young languages in, for example, newly formed communities of deaf individuals in Nicaragua (24, 26, 27), on the Amami Islands (23), and among the Al-Sayyid Bedouins (25), is beginning to reveal the nature and course of
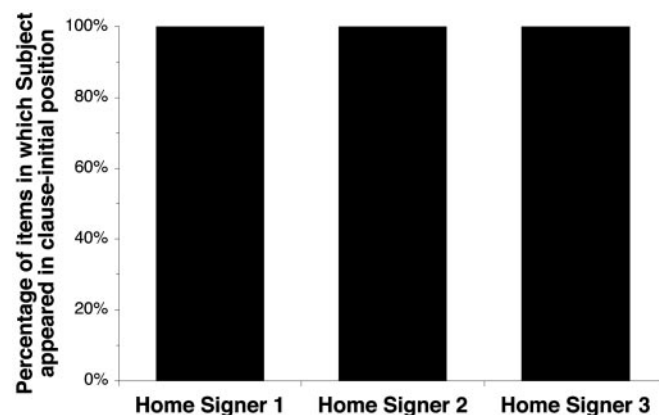

Fig. 2. Study 2: Percentage of test events in which the noun phrase referring to the primary argument was in clause-initial position (that is, percentage of test events using word order to mark Subject rather than Topic).

[‡‡]English speakers' responses, collected separately, were used to verify our assumptions about which characters are marked as Subject and Topic in a language that has devices for such distinctions. All items elicited the expected devices from English speakers.

Coppola and Newport

such emergence. But the grammatical Subject appears to be part of the bedrock on which such languages form.

1. Chomsky, N. (1965) *Aspects of the Theory of Syntax* (MIT Press, Cambridge, MA).
2. Chomsky, N. (1981) *Lectures on Government and Binding* (Foris Publications, Dordrecht, The Netherlands).
3. Feldman, H., Goldin-Meadow, S. & Gleitman, L. (1978) in *Action, Symbol, and Gesture: The Emergence of Language*, ed. Lock, A. (Academic, New York), pp. 351–414.
4. Tervoort, B. T. (1961) *Am. Ann. Deaf* **106,** 436–480.
5. Goldin-Meadow, S. (2003) *The Resilience of Language: What Gesture Creation in Deaf Children Can Tell Us About How All Children Learn Language* (Psychology Press, New York).
6. Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A. & Trueswell, J. (2005) *Lang. Learn. Dev.* **1,** 23–64.
7. Maratsos, M. & Chalkley, M. A. (1980) in *Children's Language*, ed. Nelson, K. (Gardner, New York), pp. 127–189.
8. Keenan, E. (1976) in *Subject and Topic*, ed. Li, C. (Academic, New York), pp. 304–333.
9. Comrie, B. (1989) *Language Universals and Linguistic Typology: Syntax and Morphology* (Univ. of Chicago Press, Chicago).
10. Dowty, D. (1989) in *Properties, Types, and Meaning*, eds. Cherchia, G., Partee, B. H. & Turner, R. (Kluwer, Dordrecht, The Netherlands), Vol. 2, pp. 69–129.
11. Fillmore, C. J. (1968) in *Universals in Linguistic Theory*, eds. Bach, E. & Harms, R. T. (Holt, Rinehart & Winston, New York), pp. 1–88.
12. Jackendoff, R. (1990) *Semantic Structures* (MIT Press, Cambridge, MA).
13. Bowerman, M. (1982) in *Language Acquisition: The State of the Art*, eds. Wanner, E. & Gleitman, L. R. (Cambridge Univ. Press, New York), pp. 319–346.
14. Slobin, D. I. (1982) in *Language Acquisition: The State of the Art*, eds. Wanner, E. & Gleitman, L. R. (Cambridge Univ. Press, New York), pp. 128–172.
15. Braine, M. D. S. & Hardy, J. A. (1982) in *Language Acquisition: The State of the Art*, eds. Wanner, E. & Gleitman, L. R. (Cambridge Univ. Press, New York), pp. 219–239.
16. Marantz, A. (1982) *Linguistische Berichte* **80,** 32–69.
17. Bloom, L. (1970) *Language Development: Form and Function in Emerging Grammar* (MIT Press, Cambridge, MA).
18. Bowerman, M. (1973) in *Cognitive Development and the Acquisition of Language*, ed. Moore, T. (Academic, New York), pp. 197–213.
19. Goldin-Meadow, S., Butcher, C., Mylander, C. & Dodge, M. (1994) *Cognit. Psychol.* **27,** 259–319.
20. Goldin-Meadow, S. & Mylander, C. (1984) *Monogr. Soc. Res. Child Dev.* **49,** 3–4.
21. Goldin-Meadow, S. & Mylander, C. (1990) *Language* **66,** 323–355.
22. Morford, J. & Kegl, J. (2000) in *Language and Gesture*, ed. McNeill, D. (Cambridge Univ. Press, Cambridge, U.K.), pp. 358–387.
23. Osugi, Y., Supalla, T. & Webb, R. (1999) *Sign Lang. Linguist.* **2,** 87–112.
24. Senghas, A., Coppola, M., Newport, E. L. & Supalla, T. (1997) in *Proceedings of the 21st Annual Boston University Conference on Language Development*, eds. Hughes, E., Hughes, M. & Greenhill, A. (Cascadilla, Somerville, MA), pp. 515–561.
25. Sandler, W., Meir, I., Padden, C. & Aronoff, M. (2005) *Proc. Natl. Acad. Sci. USA* **102,** 2261–2665.
26. Senghas, A. (1995) in *Proceedings of the 19th Annual Boston University Conference on Language Development*, eds. MacLaughlin, D. & McEwen, S. (Cascadilla, Somerville, MA), pp. 543–552.
27. Senghas, A. & Coppola, M. (2001) *Psychol. Sci.* **12,** 323–328.
28. Lambrecht, K. (1994) *Information Structure and Sentence Form: Topic, Focus, and the Mental Representations of Discourse Referents* (Cambridge Univ. Press, Cambridge, U.K.).

PSYCHOLOGY