Thematic role is the major determinant of forming referential dependencies

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References are flexible. When multiple referents are available, speakers have to choose one of them to continue the sentence (e.g., John in "John annoyed Mary"), and one of the referential form ("John" vs. "he"). Studies have found that speakers have preferences on these choices. Yet, little is known about how referential dependencies are built, despite also being a necessary step in reference production. This study examined how grammatical and thematic role affects the complexities of referential dependencies.

Assuming that speakers establish relationship between the upcoming references and the antecedent between the choice of referent and referential form, we controlled the choice of referential form and manipulated the properties of antecedent to explicitly measure the effects of grammatical and thematic role on dependency formation. We constrained form choice by applying Principle C ("Gary informed Anna that he got the job," where he cannot be replaced with Gary), so speakers have to use pronouns. To see if the effect is because of referent predictability, i.e., how likely a referent is mentioned the next, we assessed the predictability of each item using a force-choice task before every experiment (see (1)). In the main experiment, we measured how fast **English** speakers plan references with a picture description task (details in Fig.1). The primary dependent measure was the pre-pronoun interval, the offset from the name of the second character to the offset of "that". If a factor affects the planning of referential dependency, the pre-pronoun interval should be shorter under that condition.

Exp. 1 (N=48) manipulated VOICE (active/passive, see (2)) and REFERENT POSITION (subject/non-subject). Here, active subject and passive object are agent. Force-choice task (N=48) for predictability suggests a subject bias in both conditions (β=.31), with no evidence for a voice effect (Table 1). Despite the comparable subject bias in actives and passives, a maximally structured mixed-effects Bayesian regression revealed an interaction effect between voice and referent position on the planning speed (95% HDI:[-0.34,-0.03]); pronouns were planned faster when referring to subject referents in actives (95% HDI: [-0.03,0.20]; Table 4), but in passives, pronouns referring to subject is if anything **slower** than pronouns referring to non-subject (95% HDI:[-0.22,0.02]). These results suggest thematic role, especially agent, is the major determinant of planning referential dependencies.

Exp. 2 (N=48) tested if the passive object advantage is due to the agent status of the oblique argument. We manipulated REFERENT POSITION and the PREPOSITION following passive ("by"/"before", see (3)). The forced-choice task (N=48) again **suggests a subject bias with no difference between "by" and "before" conditions** (Table 2). Crucially, while "by" takes an agentive prepositional object, "before" does not. If the non-subject advantage in Exp.1 is due to the agent status of the oblique argument, we expect object to be planned faster in "by" but not "before". In line with this prediction, there was evidence for the interaction between preposition and referent position on planning speed (95%HDI: [-0.29,0.04]). In the 'before' condition, pronouns with subject referents were planned numerically faster ([-0.04,0.20]), but in the 'by' condition, pronouns with subject referents were again planned numerically **slower** (95%HDI: [-0.16,0.06]; Table 5). This suggests that the passive object in Exp.1 was likely due to agency.

Exp. 3 (N=48) tested if predictability has an effect when agent is absent, given the lack of predictability difference in Exp.1&2. In addition to REFERENT POSITION, we contrasted the VERB "hear from" and "inform". "Hear from" takes a goal and a source, but none of them is an agent. "Inform" takes a source and a goal, with a subject agent. The forced-choice task (N=24) suggests a source advantage in predictability (Table 3). However, source referents were not planned faster. Planning speed did not differ in "hear from" where agent is absent (Table 6). This suggests predictability does not affect the formation of referential dependencies. Taken together, our results suggest thematic role, especially agent, is the major determinant of the complexities of referential dependency. This effect is independent of grammatical role or predictability.

Example item - Fig 1. Example item used in the picture description task
Participants saw two screens for one item: The first screen (left) provides information about the first clause ("Gary informed Anna that"). They were asked to structure the first clause silently. They started to speak the whole sentence until the second screen (right) appears, which offers details about the informed event in the second clause ("he/she got the job"). Separating a sentence into two screens avoids the planning of the first clause from affecting the planning of following reference.
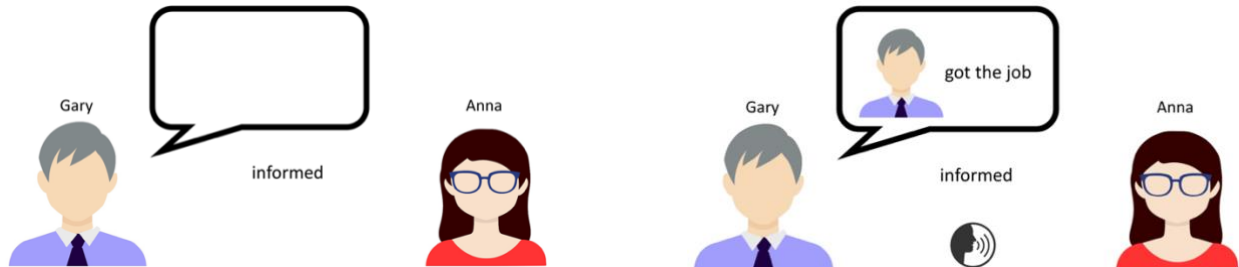
Example stimuli for norming
Participants were asked to choose the more consistent character for the given blank:
1. Gary informed Anna that _____ got the job.
    • he (Gary)   • she (Anna)

Example target stimuli
Exp 1: Active vs. Passive
2. Gary informed/was informed by Anna that he/she got the job.
Exp 2: "before" vs. "by"
3. Gary was informed before/by Anna that he/she got the job.
Exp 3: "hear from" vs. "inform"
4. Gary heard from/informed Anna that he/she got the job.

Results
Referent predictability

Table 1. % of subject referents in Exp. 1

Voice	%
Active	52.6
Passive	59.5

Table 2. % of subject referents in Exp. 2

Condition	%
"before"	56.7
"by"	55.1

Table 3. % of subject referents in Exp. 3

Condition	%
"hear from"	31.1%
"inform"	61.9%

Planning

Table 4. Length of Pre-pronoun interval in Exp. 1

Voice	Referent	Mean RT (ms)
Active	Subject	264
	Non-subject	289
Passive	Subject	277
	Non-subject	248

Table 5. Length of Pre-pronoun interval in Exp. 2

Condition	Referent	Mean RT (ms)
Passive with "before"	Subject	245
	Non-subject	274
Passive with "by"	Subject	255
	Non-subject	245

Table 6. Length of Pre-pronoun interval in Exp.3

Condition	Referent	Mean RT (ms)
"hear from"	Subject	257
	Non-subject	255
"inform"	Subject	231
	Non-subject	242