Co-operation and Co-ordination in the Production of Noun Phrases

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Abstract

We investigate the influence of two processes on noun phrase production during a referential communication task: priming (co-ordination) and audience design (co-operation). Participants played a collaborative game that involved describing picture cards (Experiment 1) or wooden blocks (Experiment 2). They interacted with a confederate who was scripted to produce particular kinds of noun phrases. As in previous studies, participants tended to be primed by the structure of the confederate's preceding description. However, they also showed evidence of tailoring their descriptions to make it easier for their addressee to carry out the task at hand.

Introduction

How would you describe the object in Figure 1? You could either call it '*a black square'*, or '*a square that's black'*. What determines which of these different forms you will produce? We explore two factors that potentially influence this kind of choice in noun phrase (NP) production: *priming* (co-ordination) and *audience design* (co-operation).

Figure 1: How would you describe this object?

In language production terms, priming is the tendency for a speaker to re-use a word or a grammatical form that they have recently processed (e.g. Bock, 1986). Audience design is the process of tailoring utterances to 'fit' a particular addressee (Bell, 1984; Clark & Carlson, 1982; Giles 1980). To date, these two processes have been studied independently by language researchers, but what happens when co-ordination and co-operation 'push' the speaker towards different choices in language production? In this paper, we report two experiments that investigate the interaction of priming and audience design during a referential communication task[1]. We begin with a brief review of previous research relating to the two phenomena.

Priming: A Mechanism for Co-ordination

In conversation, interlocutors gradually come to talk about things in similar ways. Their language behavior appears to become *co-ordinated* at a number of levels (Pickering & Garrod, in press). For example, speakers tend to use phonological variants, dialect words and grammatical constructions appropriate to their audience (e.g. Bell, 1982; Coupland, 1980; Labov, 1966). In experimental studies, interlocutors settle on shared expressions for referring to objects and entities in a reference array (Clark & Wilkes-Gibbs, 1986; Krauss & Weinheimer, 1964). This effect is particularly striking when the objects are ambiguous, or there are multiple conceptual perspectives that the speaker could take on those objects. Garrod and Anderson (1987) explain this in terms of an automatic *input-output co-ordination* mechanism that 'recycles' material from the comprehension system when generating utterances for production. Through conversation, speakers therefore come to share similar mental representations for the objects they are communicating about (Pickering & Garrod, in press).

A growing body of evidence suggests that speakers co-ordinate with an interlocutor at an abstract syntactic level during dialogue. In a study by Branigan, Pickering & Cleland, (2000), pairs of speakers took turns to talk about pictures that could be described using one of two syntactic forms (e.g. '*the nurse gave the syringe to the doctor*' or '*the nurse gave the doctor the syringe'*). One of the participants was a confederate who was scripted to produce one or the other form as a prime. The results showed that naive participants tended to repeat the syntactic form of the confederate's previous description. A similar study extended this finding to the production of noun phrases (Cleland & Pickering, in press). Speakers were more likely to produce a noun phrase like '*square that's red'* following a prime with the same syntactic structure. There is good evidence, then, that speakers co-ordinate at a number of levels in conversation. Evidence for 'co-operation' in language production, however, is less clear cut.

[1] *Referential communication tasks* typically involve pairs of participants discussing an array of picture cards or other visual stimuli. They often cannot see each other's array, and have a goal which can only be achieved by verbally collaborating on the task, such as arranging the cards in a particular order (e.g. Clark & Wilkes-Gibbs, 1986).

Audience Design and Linguistic 'Co-operation'

Audience design is the process of tailoring utterances to 'fit' an audience or addressee, according to their particular needs (Bell, 1984; Clark & Carlson, 1982; Giles 1980). An addressee's 'needs' can be determined by a variety of factors, including their prior knowledge, perspective, and what information they need in order to most easily understand the speaker's message. We can think of audience design as a *co-operative* process, because it often requires the speaker to 'decentre', or take a perspective other than their own (Piaget, 1926).

A very robust finding in the literature is that, during referential communication tasks, speakers' descriptions tend to get shorter and more efficient with repeated mention (e.g. Clark & Wilkes-Gibbs, 1986; Krauss & Weinheimer, 1964). However, speakers overcome this tendency towards increased efficiency, and go back to using longer, more elaborate references when they start talking to a new addressee (Brennan & Clark, 1996; Wilkes-Gibbs & Clark, 1992). This suggests that speakers are sensitive to how easily their partner will be able to select the correct referent from an array, and adjust the length of their description (and the amount of information it contains) accordingly. They seem to take addressee needs into account when they decide *what* to say, then, but are speakers linguistically co-operative when they decide *how* to say something?

There is some debate as to whether speakers take their addressee's perspective into account at the level of grammatical formulation (Levelt, 1989). For example, Ferreira and Dell (2000) failed to find evidence that speakers avoid producing syntactic ambiguities (which might make processing difficult for the addressee), even when their utterances are being rated for clarity by an audience. Similarly, Brown and Dell (1987) suggest that early syntactic choices are not influenced by what the addressee does or doesn't know, although Lockridge and Brennan (2002) have recently presented evidence to challenge Brown and Dell's findings.

We wanted to investigate whether speakers show evidence of audience design at the level of grammatical formulation. We also wanted to find out how priming and audience design interact in a dialogue task. Can speakers simultaneously co-ordinate and co-operate with an interlocutor? We focus on the production of noun phrases (NPs) during a referential communication task. Participants played a collaborative game that involved describing and selecting picture cards (Experiment 1) or small wooden blocks (Experiment 2) from an array. Two players participated in the game. One was a naive participant, while the other was a confederate who was scripted to produce particular kinds of NPs. We manipulated both the structure of the confederate's descriptions, and the way the stimulus array was organised in front of the two players. Naive participants' utterances were then analysed for evidence of priming (being influenced by the confederate's immediately preceding description) and audience design (producing descriptions that would be easy for their partner to map onto the array).

Experiment 1

Method

Participants 32 volunteers from Edinburgh University's student community were paid to participate. All were native speakers of English.

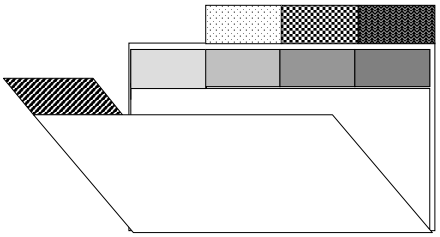

Figure 2: Dividers used to group picture cards by pattern and then by color in the *Pattern Box*

Materials and Design Two identical sets of picture cards were created. Each set contained 64 cards, which represented every possible combination of 4 colors (orange, turquoise, yellow and purple), 4 patterns (stripy, chequered, dotty and wavy) and 4 shapes (square, circle, triangle and star). Thus each set contained one stripy orange square, one stripy orange circle, one stripy orange triangle, and so on. The sets of cards were arranged in two card file boxes. In the *Pattern Box*, labelled dividers were used to group the cards by pattern and then subdivide them by color (see Figure 2). In the *Color Box*, similar dividers were used to group the cards by color and then subdivide them by pattern. In the actual experiment, the Pattern and Color boxes were marked '1' and '2' respectively, and numbered stickers on the individual cards showed which box they came from.

We also prepared two sets of instruction cards. The confederate's instructions (the prime set) had written descriptions printed on them, such that they simply had to read each instruction aloud from the card, e.g. '*Box 2, orange stripy square*'. Half of the confederate's descriptions contained *pattern-first* prime NPs (e.g. '*stripy orange square*'), and half contained *color-first* primes (e.g. '*orange stripy square*'). Instructions in the participants' set (the target set) showed which picture card they should describe to their partner on each turn. Half of the time they had to describe cards from the Pattern Box, and half of the time they had to describe cards from the Color Box.

The participant and the confederate each had 64 instruction cards to describe, made up of 16 pairs of cards in each of 4 conditions. The 4 conditions were defined by crossing Prime Type (pattern-first vs. color-first) and Target Box (whether the participant had to describe a

target card from the Pattern Box or the Color Box), yielding a 2 x 2 within-subjects design. An experimental item was defined as any combination of pattern and color in the participants' target cards. For example, the stripy orange square, circle, triangle and star cards constituted one single 'stripy orange' item. Each item appeared in 4 conditions: (1) pattern-first prime, target card from the Pattern Box; (2) pattern-first prime, target card from the Color Box; (3) color-first prime, target card from the Pattern Box; (4) color-first prime, target card from the Color Box. Equal numbers of square, circle, triangle and star cards were assigned to each condition.

An additional between-subjects manipulation was added to the design; 16 participants interacted with a 'helpful' confederate, and 16 interacted with an 'unhelpful' confederate. In the 'helpful' condition, the confederate was scripted to produce NPs in which the relative order of color and pattern adjectives matched the organisation of the box from which they were describing a card. They always produced *pattern-first* primes ('*stripy orange square*') when describing cards from the Pattern Box and *color-first* primes ('*orange stripy square*') when describing cards from the Color Box. This is helpful behavior in the sense that the naive participant should easily be able to map the confederate's description onto the structure of the stimulus array from which they must select a card. In the 'unhelpful' condition, the confederate always produced *color-first* primes ('*blue wavy circle*') when describing cards from the Pattern Box, and *pattern-first* primes ('*wavy blue circle*') when describing cards from the Color Box. This is 'unhelpful' in the sense that the naive participant cannot straightforwardly map the confederate's description onto the stimulus array. The description will need to be held in memory or the word order will have to be mentally reversed in order to retrieve the correct card.

We created 64 pairs of instructions by pairing each prime card from the confederate's set with a target card from the participant's set. There was no lexical overlap between the confederate's prime NP and the participant's immediately subsequent target NP. For example, a stripy prime card would never be followed by a stripy target, a purple prime would never be followed by a purple target, and so on. Pairs of instruction cards were randomly allocated to one of 4 lists, which were presented as 4 separate blocks of 16 trials (or 4 'games') during the experiment. Within each list, the order of prime-target pairs was randomised for each participant. At the beginning of every game, both players were given an empty 4 x 4 cardboard grid, and were instructed to fill this up with picture cards working left-to-right, top-to-bottom, starting in the top-left corner.

Procedure The confederate and participant were seated on opposite sides of a table, with the two boxes of picture cards between them. Instruction cards were placed to the side of the players in card file boxes. Both players read instructions explaining the aim of the communication game: to fill up their empty grids with picture cards as quickly and as accurately as possible. They alternated between two tasks: describing instruction cards to their partner, and selecting picture cards to put on their own grid. The players were invited to look inside the boxes at the start of the session, to find out what was inside. The experimenter explained that it was very important when giving instructions to provide enough information for the other player to find the right card from the correct box. In every game, the confederate always gave the first description. The experiment took about 40 minutes in total.

Each session was recorded on audio tape and later transcribed verbatim. We coded the NPs produced by participants as PATTERN-COLOR (e.g. '*stripy orange square*'), COLOR-PATTERN (e.g. '*orange stripy square*') or OTHER[2].

Results

Table 1 reports the percentages of COLOR-PATTERN NPs produced in each condition. Speakers show a bias towards mentioning color before pattern in their descriptions, and this probably reflects the fact that color adjectives are more frequent (and therefore more accessible, in production terms) than pattern adjectives[3]. Analyses of variance were conducted, with Prime Type (pattern-first vs. color-first) and Target Box (Pattern Box vs. Color Box) as within-subjects factors, and Confederate Type (Helpful vs. Unhelpful) as a between-subjects factor. Separate analyses treated participants (*F1*) and items (*F2*) as random effects. There was a highly significant main effect of priming overall ($F1 = 11.689$, $p = .002$; $F2 = 107.705$, $p < .001$). Participants produced 20% more COLOR-PATTERN NPs following a color-first prime from the confederate. There was no significant effect of Target Box overall ($F1 = .136$, $p = .714$; $F2 = .228$, $p = .640$), and no interaction between Prime Type and Target Box ($F1 = .043$, $p = .8383$; $F2 = 1.121$, $p = .306$). However, there were some interesting differences between the 'helpful' and 'unhelpful' conditions.

[2] NPs were coded as OTHER if the speaker did not produce a noun phrase of the form ADJECTIVE-ADJECTIVE-NOUN, or (in a small number of cases) because the target card had not been preceded by the correct prime description from the confederate. OTHER responses represented 3% of the data and were excluded from all analyses, such that percentages of COLOR-PATTERN and PATTERN-COLOR NPs were complementary. We therefore report results and analyses for COLOR-PATTERN NPs only. Of the excluded descriptions, 67% mentioned color before pattern, and 33% mentioned pattern before color.

[3] In a previous study using the same stimuli, speakers spontaneously produced COLOR-PATTERN NPs on 61% of trials at baseline, compared to 39% PATTERN-COLOR NPs (Haywood, Branigan & Pickering, unpublished data).

Table 1: Percentage COLOR-PATTERN NPs (SD)

	Participant describes target card from:	
	Pattern Box	Color Box
Helpful confederate		
pattern-first prime	46 (31)	48 (30)
color-first prime	74 (29)	79 (26)
Unhelpful confederate		
pattern-first prime	49 (27)	46 (27)
color-first prime	62 (32)	56 (30)

In the 'helpful' condition, participants produced 30% more COLOR-PATTERN NPs following a color-first prime from the confederate ($F1$ = 11.502, p = .004; $F2$ = 86.913, p < .001). They also showed a trend (in the subjects analysis) towards tailoring their NP to fit the box from which they were describing a card ($F1$ = 3.577, p = .078; $F2$ = .568, p > .1). In the 'unhelpful' condition, participants showed a smaller priming effect (12%, $F1$ = 2.0303, p = .175; $F2$ = 31.190, p < .001) and a *negative* effect of Target Box (–5%, $F1$ = 3.428, p = .084; $F2$ = 7.333, p = .016). In other words, participants interacting with an unhelpful confederate were *less* likely to mention color before pattern when the target card was to be selected from the Color Box. Most interestingly, there was an interaction between Confederate Type and Target Box ($F1$ = 6.824, p = .014; $F2$ = 5.550, p = .033); participants in the 'helpful' condition were significantly more likely to engage in audience design than participants in the 'unhelpful' condition (but there was no interaction between Confederate Type and Prime Type in the subjects analysis; $F1$ = 2.037, p = .164; $F2$ = 16.086, p = .032).

Discussion

Participants produced NPs that were co-ordinated with the confederate's descriptions at the level of word order. They mentioned color before pattern in their target description about 20% more often following a color-first prime ('*orange stripy square*') than after a pattern-first prime ('*stripy orange square*'). Participants in the 'helpful' confederate condition showed a stronger co-ordination effect than participants in the 'unhelpful' condition (30% vs. 12%, respectively).

Overall, there was no significant effect of Target Box on word order. Participants didn't appear to be tailoring the relative order of pattern and color adjectives according to the box from which their partner would have to choose a card. This suggests that the generation of word order during language production is not sensitive to information about what would make the task easier for the addressee. Alternatively, perhaps participants are simply not concerned with audience design in this task. However, the interaction between Target Box and Confederate Type suggests that information about the addressee's 'needs' *does* have an effect on word order, so long as the speaker is interacting with an interlocutor who is also behaving co-operatively. Participants in the 'helpful' condition were significantly more likely (than participants in the 'unhelpful' condition) to mention color before pattern when they described a card from the Color Box. This suggests that word order can be sensitive to audience design, under the right conditions.

We wanted to find out whether audience design has an influence on grammatical stages of language production. However, although word order is generally considered to be a component of grammatical formulation (e.g. Levelt, 1989), we cannot really call our audience design effect a syntactic phenomenon. COLOR-PATTERN NPs ('*orange stripy square*') are syntactically identical to PATTERN-COLOR NPs ('*stripy orange square*'), so our data do not speak to the question of whether speakers choose particular syntactic forms in order to be co-operative towards an addressee (cf. Brown & Dell, 1987; Ferreira & Dell, 2000; Lockridge & Brennan, 2002). We therefore decided to look at audience design using a noun phrase manipulation that would involve a choice between different syntactic structures. In Experiment 2, players took part in a similar kind of communication game, but this time they talked about small wooden blocks that differed along just two dimensions: color and shape. The confederate was scripted to produce descriptions which either mentioned color first (e.g. '*red square*') or shape first ('*square that's red*'). We wanted to maximise the likelihood of observing an audience design effect, so we had all of our participants interact with a 'helpful' confederate.

Experiment 2

Method

Participants 16 volunteers from Edinburgh University's student community participated for payment. All were native speakers of English, and none had taken part in Experiment 1.

Materials and Design 2 identical sets of 16 wooden blocks were used in the experiment. In each set, there were 4 square blocks, 4 circles, 4 triangles and 4 bridge shapes. One of each shape was red, one was blue, one was green and one was yellow. The two sets were arranged in cardboard chests of drawers, which were labelled '1' and '2' on the top. Each chest contained 4 pull-out drawers. In Box 1 (which we'll refer to as the *Color Box*), the drawers were labelled with colored patches to indicate that one drawer contained all the red blocks (one square, one circle, one triangle, one bridge), one contained all the blue blocks, and so on. The drawers in Box 2 (the *Shape Box*) were labelled with pictures to indicate that one contained all the square blocks (one red, one blue, one green, one yellow), one contained all the circle blocks, etc. Individual blocks were labelled with numbered stickers to show whether they came from Box 1 or Box 2.

Two sets of instruction cards were created for the players to describe. The confederate's instruction cards

(the prime set) had written descriptions printed on them, so that they could simply read each instruction aloud. The confederate's descriptions were written such that they always used a *color-first* prime NP (e.g. '*red square*') to describe a block from the Color Box and a *shape-first* prime (e.g. '*square that's red*') to describe a block from the Shape Box. Each of the participants' instructions (the target set) showed a pictorial representation of a 5 x 4 grid with a wooden block in one square. The picture also indicated which box the block should come from (1 or 2). Half of the participants' instructions showed a block from Box 1, and half showed a block from Box 2.

32 pairs of instruction cards were created by pairing a prime card from the confederate's set with a target card from the participant's set. Pairs were constructed so that there was no lexical overlap between the prime NP and the target NP. In other words, the color and shape of the target block were always different to the color and shape of the block in the immediately preceding prime. An experimental item was defined as the confederate's scripted prime description plus the participant's paired target card.

Prime-target pairs were assigned to one of two lists, which were presented as two separate blocks of 16 trials (or two 'games') during the experimental session. The two lists were constructed such that every wooden block was described only once in each list. Within each block, the order of presentation of prime-target pairs was randomised for each participant. Both players started the game with an empty 5 x 4 grid in front of them. The columns of the grid were labelled with numbers (1-5) and the rows were labelled using letters (A-D).

Procedure This was almost identical to Experiment 1, except that there were only 2 blocks of 16 trials. The confederate always described the first card. Each player had 4 empty spaces on their grid at the end of a game. Between games, the experimenter put the wooden blocks back into the chests of drawers, removed the players' filled grids and replaced them with empty ones. The experiment took about 25 minutes in total.

Each session was recorded on audio tape and later transcribed verbatim. We coded the descriptions produced by participants as ADJECTIVE-NOUN (e.g. '*red square*'), NOUN-RELATIVE (e.g. '*square that's red*') or OTHER[4].

Results

Table 2 reports the percentage of ADJECTIVE-NOUN NPs ('*red square*') produced in each condition. NPs coded as OTHER are excluded from these percentages, and from all subsequent analyses. 2 x 2 analyses of variance were conducted, with Prime Type (color-first vs. shape-first) and Target Box (Color Box vs. Shape Box) as within-subjects factors[5]. These analyses revealed a small but very reliable main effect of priming ($F1$ = 7.941, p = .013; $F2$ = 12.293, p = .002). Speakers produced 5% more ADJECTIVE-NOUN NPs (e.g. '*blue triangle*') following a color-shape prime than after a shape-first prime. There was also a significant main effect of Target Box ($F1$ = 4.410, p = .053; $F2$ = 98.683, p < .001). Speakers produced 13% more ADJECTIVE-NOUN NPs when describing blocks from the Color Box. The interaction between Prime Type and Target Box was significant by items but not by subjects ($F1$ = 3.333, p = .088; $F2$ = 5.463, p = .027).

Table 2: Percentage ADJECTIVE-NOUN NPs (SD)

	Participant describes target block from:	
	Color Box	Shape Box
Confederate produces:		
color-first prime	99 (3)	89 (0.26)
shape-first prime	98 (7)	81 (0.27)

Discussion

Experiment 2 found significant independent effects of co-ordination and co-operation on noun phrase production. As in a previous study (Cleland & Pickering, in press), speakers were more likely to produce a noun-relative structure ('*square that's red*') after a shape-first prime than following a color-first prime. We interpret this as a syntactic co-ordination effect (cf. Branigan, Pickering & Cleland, 2000). Speakers also produced more noun-relative NPs when describing blocks from the Shape Box. This suggests that our participants were tailoring their descriptions to produce NPs that would map easily onto the array from which their partner would have to select a block. We take this as evidence that speakers were behaving 'co-operatively' at the level of syntactic choice.

The magnitude of the effects in this experiment are somewhat different to those we observed in Experiment 1. The overall priming effect is smaller here, probably because one of the constructions we were trying to get participants to produce ('*square that's red*') is fairly dispreferred in spontaneous speech (in a previous study, speakers produced this kind of construction on only 9% of baseline trials; Haywood, Branigan & Pickering, unpublished data). Although there seems to be a preference for producing color adjectives before pattern adjectives, speakers do spontaneously produce both of the two word orders we investigated in Experiment 1 ('*stripy orange star*' vs. '*orange stripy star*'), and they are therefore perhaps easier to prime. The co-operation effect is more reliable in Experiment 2, and this might reflect the fact that the confederate was modelling the production of syntactic structures that were obviously very different from each other ('*red square*' versus '*square that's red*').

[4] Descriptions were coded as OTHER if they did not contain information about both the shape and color of the card.

[5] The items analyses we report here are between-items comparisons.

This might have the effect of highlighting the target box manipulation, making it more likely that the naive participants will pay attention to audience design in their own utterances.

General Discussion

Two experiments demonstrate that speakers co-operate and co-ordinate with an interlocutor when they produce noun phrases. In line with previous research, our data demonstrate that NP structure can be primed in dialogue (cf. Cleland & Pickering, in press). This supports the idea that abstract aspects of linguistic input have an impact on a speaker's language *output* (e.g. Bock, 1986; Garrod & Anderson, 1987).

Our participants also showed evidence of attending to audience design in the dialogue task. They tended to produce NPs that would most easily map onto the stimulus array for their partner, even when that involved producing constructions which are rarely used spontaneously (such as NPs like '*square that's red*'). Speakers appeared to be more likely to engage in audience design when the contrast between the possible referring expressions was very obvious (Experiment 2), and when their partner was also behaving in a linguistically 'co-operative' way (Experiment 1). This latter finding suggests that there may be some element of 'tit-for-tat' in language behavior; speakers may not bother to be helpful unless the person they are talking to is doing the same.

Co-ordination and co-operation exerted independent effects in the experiments we report here, and in both studies, the priming effect was (statistically) more reliable than audience design. This may well reflect the fact that priming is thought to operate at an automatic, non-conscious level (Bard, Anderson, Sotillo, Aylett, Doherty-Sneddon & Newlands, 2000; Pickering & Garrod, in press), whereas audience design is considered to be a more strategic process (Bard et al., 2000; Horton & Keysar, 1996) that may require conscious effort on the part of the speaker. Perhaps people only attend to an addressee's perspective when time or processing resources allow.

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