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Ordering adjectives in referential communication

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ABSTRACT

We contrasted two hypotheses concerning how speakers determine adjective order during referential communication. The *discriminatory efficiency* hypotheses claims that speakers place the most discriminating adjective early to facilitate referent identification. By contrast, the *availability-based ordering* hypothesis assumes that speakers produce most available adjectives early to ease production. Experiment 1 showed that speakers use more pattern-before-color modifier orders (than the reversed) when pattern, not color, distinguished the referent from alternatives, providing support for the discriminatory efficiency hypothesis. Participants also overspecified color more often than pattern, and they generally favored color-before-pattern orders, in support of the availability-based ordering hypothesis. Experiments 2 and 3 replicated both effects in a dialogue setting, where speakers' adjective ordering was also primed by their partner's ordering, using conjoined and non-conjoined constructions. We propose a novel model (*PASS*) that explains how discriminability and availability simultaneously influence adjective selection and ordering via competition in the speaker's message representation.

Introduction

When producing multiple modifiers, speakers do not order them randomly. In English and other similar languages, *the large red car* is much more preferred than *the red large car*. Previous research on adjective order has focussed on identifying underlying *semantic constraints* (e.g., Dixon, 1982; Hetzron, 1978; Quirk, Greenbaum, Leech, & Svartvik, 1985; Scott, 2002; Whorf, 1945), whereby size typically occurs further from the noun than shape (*large round table* rather than *round large table*) or color (*large red car* rather than *red large car*). The main conclusion from these studies has been that adjectives that denote more *absolute* (Martin, 1969b), *intrinsic* (Danks & Glucksberg, 1971), *inherent* (Quirk et al., 1985; Whorf, 1945) or *subjective* (Hetzron, 1978; Scontras, Degen, & Goodman, 2017) semantic properties occur closer to the noun. Yet speakers do not always follow such semantic rules (Mitchell, 2009; Ney, 1986). An important question for psychological theories of language production concerns what cognitive and communicative constraints might underlie adjective ordering. Whereas research has concentrated on *what* property speakers tend to choose in referential descriptions (e.g., Dale, 1989; Dale & Reiter, 1995; Deutsch & Pechmann, 1982; Frank & Goodman, 2012), much less attention has been paid to *how* speakers express those properties (i.e., *formulation* as opposed to *message generation*, Levelt, 1989). The purpose of the present study was to address this, by uncovering the processes and representations that underlie adjective ordering.

Property selection

When the context contains similar referential candidates, speakers normally refer to the referent's distinguishing property to avoid referential ambiguity. Research has shown that the likelihood of speakers referring to a particular property of the referent (e.g., size as in *large circle*) is higher when the context contains similar category exemplars (e.g., multiple circles) than when the referent is the only category exemplar (e.g., Ferreira, Slevc, & Rogers, 2005; Horton & Keysar, 1996; Pechmann, 1989). Some computational models of object specification therefore focus on contextual discriminability to predict which properties speakers are likely to refer to (Dale, 1989; Frank & Goodman, 2012). Frank and Goodman (2012), for instance, proposed that the likelihood in which speakers choose a particular property of the referent, amongst alternatives, is inversely related to the number of referential candidates to which the property can apply: The fewer referential candidates the property can be applied to, the more informative it is for identifying the referent, leading to a higher likelihood of reference. Suppose color discriminates your intended referent from other referential candidates, whereas size does not (e.g., the referent is the only red circle in the context, but there are several small circles). The chance that you will then refer to color rather than size is higher compared to when size but not color is discriminating. The preference for choosing the most discriminating property over less discriminating ones is in accord with Dale (1989), who regarded it as a heuristic for producing the shortest-possible distinguishing referring expressions, in

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keeping with the Gricean assumption that cooperative speakers should be *optimally* informative (Grice, 1975).

However, speakers do not always produce *minimally-specified* descriptions; instead, they often *overspecify* (Pechmann, 1989). Speakers often add a modifier when other properties of the description alone can identify the referent uniquely (e.g., Deutsch & Pechmann, 1982; Engelhardt, Bailey, & Ferreira, 2006; Pechmann, 1989) or when the additional modifier does not rule out any referential alternative (e.g., Belke & Meyer, 2002; Gatt, Krahmer, Van Deemter, & Van Gompel, 2016; Koolen, Goudbeek, & Krahmer, 2013). A possible reason for *overspecification* is that speakers try to be informative by providing additional cues that might help referent identification. For instance, Arts, Maes, Noordman, and Jansen (2011) showed that participants were more likely to overspecify when the task required more precise instructions than not. An alternative possibility is that when starting to speak, speakers do not necessarily know exactly which property is fully distinguishing. Using eye-tracking, Pechmann (1989) found that nearly all participants began articulating referring expressions before fixating all objects in the referential scene. Comparing the referent against every single referential alternative in the context requires time. Hence, Pechmann suggested that selection might begin with properties that are most easily recognisable rather than those that can rule out as many alternatives as possible. Dale and Reiter (1995) formalized such model, termed the *incremental algorithm*. In this model, the selection of properties is primarily led by *preference* rather than discriminability, as the algorithm simply iterates through a list of properties ranked according to the degree of preference. Preferred properties will be incrementally added to the description, ruling out at least one referential competitor that has not yet been ruled out, until the referring expression is fully distinguishing. An added property cannot be *backtracked* even if it results in redundancy. Hence, assuming that speakers select properties according to their preference, the model explains why speakers sometimes overspecify.

Adjective ordering

The aforementioned models are primarily concerned about *what* properties speakers tend to select in a given referential context, avoiding the question of *how* speakers sequence the chosen properties. Nevertheless, we can derive predictions pertaining to adjective ordering, by assuming that constraints that affect adjective selection also influence adjective ordering. Specifically, we may hypothesize that discriminability affects not only property selection but also word order. The communicative benefits of early discrimination are evident from research showing that comprehenders interpret speech incrementally. Eberhard, Spivey-Knowlton, Sedivy, and Tanenhaus (1995) reported that the position of the discriminating word in a referential description determines latencies of eye fixations onto the target referent: When listening to instructions like *Touch the starred yellow square*, addressees were quicker at fixating the target square when the first adjective (*starred*) rather than the second adjective (*yellow*) provided the discriminating cue. Hence, if speakers formulate referring expressions to facilitate early referent identification, they should be more likely to place the most discriminating modifier (i.e., one that rules out most referential alternatives) in an earlier position. We call this the *discriminatory efficiency hypothesis*.

However, language production research generally suggests that speakers choose a particular word order to ease production rather than comprehension. Specifically, availability-based production models assume that speakers preferentially choose word orders that allow the earlier placing of words or phrases that are more available to them to facilitate production (Bock, 1982, 1986a; Bock & Irwin, 1980; Bock & Warren, 1985; Ferreira & Yoshita, 2003; McDonald, Bock, & Kelly, 1993; Prat-Sala & Branigan, 2000; Tanaka, Branigan, Mclean, & Pickering, 2011). Studies have found that availability due to conceptual salience (Bock & Warren, 1985; McDonald et al., 1993; Tanaka et al., 2011), semantic priming (Bock, 1986a), or discourse *givenness* (Bock & Irwin, 1980; Ferreira & Yoshita, 2003) influences the choice between active and passive voice (e.g., *The doctor administered the shock* vs. *The shock was administered by the doctor*) and dative alternations (e.g., *The rancher sold the cowboy the horse* vs. *The rancher sold the horse to the cowboy*). The assumption is that the incremental production of highly available words or phrases facilitates production processes, as it minimizes the need of buffering available information in memory. Hence, if similar production constraints underlie adjective ordering, speakers should preferentially select and order more salient or available properties early to facilitate reference production. We call this the *availability-based ordering hypothesis*.

Previous research

Experimental work on adjective ordering has mostly focused on understanding the nature of the preference for the size-before-color order observed in many languages. Although the findings from these studies were inconclusive, as we discuss below, the researchers proposed important predictions concerning how discriminability and availability might influence adjective ordering.

First, Danks and colleagues examined the link between discriminability and the ordering preference of size-before-color adjectives in the 1970s. Specifically, Danks and Glucksberg (1971) proposed that properties that are more intrinsic to the referent identity, such as color, tend to occur closer to the noun, because they are less informative for discrimination compared to those that are less intrinsic, such as size (e.g., *a large yellow banana;* bananas are usually yellow, whereas their size may vary). That is, speakers place less intrinsic adjectives before more intrinsic ones to facilitate discrimination (see Oller & Sales, 1969, for a similar proposal). In languages with pre-nominal modification, this means that less intrinsic and hence more discriminating adjectives should occur earlier, consistent with the discriminatory efficiency hypothesis. Danks and Schwenk (1972) tested this proposal by having English-speaking participants describe an object in a visual array, which contained a referential competitor that contrasted with the target in either color, size or both. Regardless of which property discriminated the target from the competitor, participants almost invariantly produced size-before-color orders (see also Belke, 2001, for similar results in German). When participants had to choose, amongst alternatives, a spoken instruction that would correctly identify the referent, they sometimes shifted their preference to the color-before-size order if color was distinguishing in the context. Yet this happened only when the first-mentioned adjective was stressed. When color was distinguishing, the color-before-size order had the distinguishing property stressed, whereas the size-before-color order had the non-distinguishing property stressed. The reverse was the case when size was distinguishing; the distinguishing property was stressed in the size-before-color order, but the non-distinguishing property was stressed in the color-before-size order. Engelhardt and Ferreira (2014) recently found that distinguishing modifiers tend to have a longer articulatory duration than non-distinguishing modifiers. Hence, because Danks and Schwenk had no counterbalancing condition, where the second-mentioned adjective was stressed, it remained unclear whether the preferences were due to the word order or stress (Richards, 1975). Moreover, we do not know whether and to what extent *comprehension* preferences might inform production preferences (Pechmann, 1989; Schriefers & Pechmann, 1988). Therefore, it remains open whether discriminability affects adjective ordering.

Second, Schriefers and Pechmann (1988) discussed the role of availability in adjective ordering when they conjectured that the preference for size-before-color orders reflects the scope of initial conceptual planning. In their study, speakers almost always referred to an object's semantic category (denoted by the head noun), regardless of whether it was required for unique identification. Likewise, speakers frequently mentioned an object's color when it did not contribute to its