



Original Articles

Grammatical gender affects gender perception: Evidence for the structural-feedback hypothesis



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ABSTRACT

Two experiments assessed the extent to which grammatical gender provides a predictive basis for bilinguals' judgments about perceptual gender. In both experiments, French-English bilinguals and native English monolinguals were consecutively presented with images of objects manipulated for their (i) conceptual gender association and (ii) grammatical gender category and were instructed to make a decision on a subsequent target face. The experiments differed in the implicitness of the association between the object primes and target faces. Results revealed that when prior knowledge sources such as conceptual gender can be strategically used to resolve the immediate task (Experiment 1), this information was readily extracted and employed. However, grammatical gender demonstrated a more robust and persisting effect on the bilinguals' judgments, indicating that the retrieval of obligatory grammatical information is automatic and modulates perceptual judgments (Experiment 2). These results suggest that grammar enables an effective and robust means to access prior knowledge which may be independent of task requirements.

1. Introduction

The notion that the languages we speak are responsible for shaping our thoughts can be traced back to Whorf's classic principle of linguistic relativity (Whorf, 1956). A view that has stirred heated discussions regarding the extent of its influence (Pinker, 1994), recent questions are now geared toward understanding how languages may contribute in modulating non-verbal cognition (Athanasopoulos, Bylund, & Casasanto, 2016). Specifically, language or labels (i.e., words) are now characterized as offering a conceptual basis that motivates the top-down processing of perceptual information (e.g., Lupyan, 2012; Lupyan & Clark, 2015). Although a substantial body of studies on the representation of color (e.g., Davidoff, Davies, & Roberson, 1999; Roberson, Davies, & Davidoff, 2000; Thierry, Athanasopoulos, Wiggert, Dering, & Kuipers, 2009; Winawer et al., 2007), time (e.g., Boroditsky, 2000; Casasanto & Boroditsky, 2008) and number (e.g., Dehaene, Spelke, Pinel, Stanescu, & Tsivkin, 1999; Frank, Everett, Fedorenko, & Gibson, 2008) point in favor of such a view, existing research has not yet been able to fully characterize the scope in which more complex linguistic features such as grammar may permeate and guide our cognitive processes.

In the study reported here, we sought to assess the extent to which grammatical information influences perceptual judgments by employing grammatical gender and conceptual gender information as

testbeds to guide our investigation. Grammatical gender refers to a system of assigning noun class found in a vast majority of the languages in the world (Corbett, 1991). Contrary to languages such as English which do not incorporate such grammatical systems, grammatical gender languages such as French arbitrarily assign all nouns to a formal grammatical category (e.g., grammatically masculine: *couteau* [knife] vs. grammatically feminine: *cuillère* [spoon]). In contrast, conceptual gender concerns the conceptual properties of an object relating to either gender (e.g., conceptually male: *hammer* vs. conceptually female: *necklace*) which is not determined by linguistic or natural (i.e., biological) gender categories (Sera, Berge, & del Castillo-Pintado, 1994). Given that gender information spans on both grammatical and conceptual levels of representation, it provides a convenient case to evaluate the relationship between language and thought.

In fact, grammatical gender has been commonly employed to fuel the debate on linguistic relativity (see Cubelli, Paolieri, Lotto, & Job, 2011 for an exhaustive review of different empirical paradigms). Studies employing voice attribution (e.g., Flaherty, 2001; Sera et al., 1994), trait attribution (e.g., Boroditsky, Schmidt, & Phillips, 2003; Konishi, 1993) and inference generation (e.g., Imai, Schalk, Saalbach, & Okada, 2014; Saalbach, Imai, & Schalk, 2012) tasks suggest that language users rely on grammatical gender membership of an entity to infer its sex-related properties, even in cases where gender information should not be relevant. Although these studies provide evidence to

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suggest that grammatical information is readily mapped onto an entity's semantic representation, the implemented paradigms are explicit and constrain these findings to cases where speakers consciously engage in verbal processing.

This is not to say, however, that grammatical features exhibit only superficial effects on general cognition. Theoretical frameworks such as connectionist approaches provide an alternative explanation to the contribution of language on thought. Under this notion, the human mind is characterized as being highly interactive, where features such as language are considered to play an active role during the encoding of concepts and categories (e.g., Rumelhart, McClelland, & PDP Research Group, 1986). Lupyan's (2012) label-feedback hypothesis draws upon such notions, particularly emphasizing the role of language, suggesting that categorical labels (i.e., words) modulate visual perception. Learning to associate properties of an entity with a specific label allows the perceiver to abstract distinctive features of a given exemplar to a more typical category. Predictions triggered from the label are thus activated and successively fed back in a top-down manner, causing a temporary modulation on on-line perceptual representations. Hearing a redundant label in a visual search task, for example, has been shown to enhance detection by directing attentional focus to the stimuli's prototypical features (e.g., Lupyan & Spivey, 2010a, 2010b; Lupyan & Ward, 2013). Labels are thus expected to streamline perceptual representation by heightening features of the relevant stimuli.

Notwithstanding the broad appeal of Lupyan's framework, it does not fully account for the structural influences brought on by linguistic features such as grammar and syntax, which are essentially more complex than single labels (Thierry, 2016). These considerations are critical; language processing is inherently dynamic, inasmuch as locally attending to structural and agreement relationships is requisite and obligatory for the language user (Lucy, 1997). To the extent that the exposure to languages or acquisition of new linguistic constructions may even restructure our conceptual representations (e.g., Athanasopoulos, 2006; Majid, Bowerman, Kita, Haun, & Levinson, 2004), it is unlikely that the effects of language are restricted to the retrieval of labels.

Indeed, a wealth of recent studies has shown that perceptual modulations can bear the consequence of syntactic and grammatical encodings of specific languages (e.g., Athanasopoulos & Bylund, 2013; Boutonnet, Athanasopoulos, & Thierry, 2012; Casasanto & Boroditsky, 2008; Fausey & Boroditsky, 2010). This is exemplified by research on motion event construal demonstrating a link between perceivers' attentional predispositions and the syntactic framing of motion events in their respective languages (e.g., Athanasopoulos & Bylund, 2013; Athanasopoulos et al., 2015; Flecken, Athanasopoulos, Kuipers, & Thierry, 2015). For example, Flecken et al. (2015) compared attention allocation during motion event perception among English and German speakers. Given that English linguistically emphasizes trajectory and endpoint of motion as opposed to only endpoints in German, their study found distinct language-consistent preferential biases of motion aspect. Specifically, attention was more heavily allocated to aspects that were linguistically encoded in each language, although the task did not require any conscious verbal processing. More relevant to the present study is evidence provided by Boutonnet et al. (2012), who demonstrated that morphological properties such as grammatical gender impose a significant impact on categorization. In their study, native English speakers and Spanish-English bilinguals were presented with three object images and were instructed to judge if the third target object image belonged to the same semantic category to the previous two objects. They found that while all participants were sensitive to the semantic associations between the objects, the bilinguals were also affected by the hidden manipulation of their grammatical gender membership in Spanish. The authors concluded that language-based properties were automatically accessed during object categorization and were subsequently fed back into lower-level perceptual processes even in conditions where linguistic mediation was unwarranted.

The aforementioned studies provide substantial evidence pointing to the inherent complexity of the top-down influences of language. Flecken et al. (2015) acknowledged the possibility that the different perceptual biases observed in their study could have originated from speakers essentially labeling event trajectory and endpoints. This would allow label-feedback effects to arise (i.e., labels activating diagnostic features) and preserve the reported language-specific properties. However, the findings of Boutonnet et al. (2012) confirm that grammatical gender is covertly recruited, and suggest that the information that is fed back to the perceptual system extends far beyond the impact that mere labels may activate. Assuming that grammatical gender categories operate as an obligatory and formal grammatical cue, it stands to reason that they may cast a more significant influence on perceivers' categorical decisions than would single labels.

The effects of language can thus be characterized as predisposing perceivers' attention to aspects that are linguistically realized, with grammar providing a *structural feedback* that guides our perceptual processes. In other words, although grammatical gender may lack semantic relevance to the lexical or conceptual representation of an entity, it nonetheless is a salient and obligatory feature. The encoding of this information and the constant attention it warrants would most likely structure a speakers' tendency in adhering to this category. Consequently, this would result in guiding or biasing the perceptual categorization of incoming information. Such a view ties in well with a predictive processing account that considers prior knowledge as modulating our perceptual representations (Lupyan & Clark, 2015). According to this framework, prior knowledge is rapidly recruited from long-term memory, allowing perceivers to generate probable expectations about incoming sensory information. In doing so, the information is contextualized through meaningful predictions, moderating predictive errors that are otherwise expected to arise. An intricate interaction is therefore expected between top-down predictions and incoming information, allowing perceivers to refine their perceptual experiences. For instance, our prior knowledge that dogs bark enables us to discern dogs from other furry animals that may resemble a similar entity. By the same token, language and their grammatical structures should activate information relevant to a given situation, affording more efficient means to retrieve top-down predictions.

The study reported here focuses on understanding the extent to which such grammatical structures may penetrate the biases emerging in our perceptual judgments. Specifically, we compared the influences grammatical gender may impose on categorization to that of non-linguistic prior knowledge about an object's associated conceptual gender. Past studies have shown that prior knowledge about a prime's conceptual gender information influences judgments in assessing the gender typicality of target facial stimuli, as demonstrated by exposure to gendered objects (Utz & Carbon, 2015), hormones (Kovács et al., 2004), and speech frequency (Smith, Grabowecy, & Suzuki, 2007). Here, two experiments utilizing an object triad task were carried out in an English-exclusive environment, to determine the extent to which grammatical gender would modulate perceptual judgments about the sex of facial stimuli. French-English bilinguals were compared against monolingual English-speaking controls where only English was spoken. Because English is not marked for grammatical gender, any grammatical gender effects that may be observed among the French-English bilinguals would provide evidence of the bilinguals' usage of language that is not being actively employed. In this manner, we aimed to provide evidence as to how grammatical gender may modulate cognitive processes during a task that did not necessitate its activation. In each experiment, participants were primed with two object images strongly associated with a conceptual gender and were instructed to make a sex-related judgment on a target facial image. The objects were manipulated for their (i) conceptual gender association and (ii) grammatical gender category.

In Experiment 1, participants were required to link the conceptual gender association of the object primes to the sex of the subsequent

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