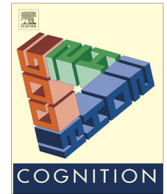




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Brief article

Natural forces as agents: Reconceptualizing the animate–inanimate distinction



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ABSTRACT

Research spanning multiple domains of psychology has demonstrated preferential processing of animate as compared to inanimate entities—a pattern that is commonly explained as due to evolutionarily adaptive behavior. Forces of nature represent a class of entities that are semantically inanimate but which behave as if they are animate in that they possess the ability to initiate movement and cause actions. We report an eye-tracking experiment demonstrating that natural forces are processed like animate entities during online sentence processing: they are easier to integrate with action verbs than instruments, and this effect is mediated by sentence structure. The results suggest that many cognitive and linguistic phenomena that have previously been attributed to animacy may be more appropriately attributed to perceived agency. To the extent that this is so, the cognitive potency of animate entities may not be due to vigilant monitoring of the environment for unpredictable events as argued by evolutionary psychologists but instead may be more adequately explained as reflecting a cognitive and linguistic focus on causal explanations that is adaptive because it increases the predictability of events.

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1. Introduction

The fundamental distinction between animate and inanimate entities is regarded as an important factor in language and cognitive processing. In language research, animacy is considered a linguistic universal (Comrie, 1989)—one that powerfully affects the acquisition of grammatical knowledge (Brown, 1973), the process of sentence comprehension (Clifton et al., 2003), and the degree of language impairment in patients with aphasia and other neuropsychological conditions (Capitani, Laiacona, Mahon, & Caramazza, 2003). For cognition more generally, animate stimuli capture visual attention more quickly and hold attention longer than inanimate stimuli (Abrams & Christ, 2003; Johansson, 1973; Pratt, Radulescu, Guo, & Abrams,

2010). The distinction between animate and inanimate is a critical component of semantic knowledge (Caramazza & Mahon, 2003), emerges early in development (Opfer & Gelman, 2011), and is associated with distinct patterns of brain activation (Caramazza & Shelton, 1998; Gobbini et al., 2011). Finally, words or pictures representing animate entities are better remembered than those representing inanimate entities (Bonin, Gelin, & Bugaiska, 2014; Nairne, VanArsdall, Pandeirada, Cogdill, & LeBreton, 2013; VanArsdall, Nairne, Pandeirada, & Cogdill, 2014).

Findings showing the importance of animacy are frequently explained from an evolutionary psychology perspective (e.g., *animate monitoring hypothesis*; New, Cosmides, & Tooby, 2007). Given that our primitive ancestors were primarily concerned with survival, the ability to rapidly detect animals in the visual field and determine whether they were potential predators or prey would seem to be a highly advantageous skill. In addition, survival and reproduction likely depended on the ability to remember

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which humans were friends, enemies, or potential mates. More generally, New et al. argue that the behavior of humans and animals is largely unpredictable, which would have made it especially advantageous for our ancestors to carefully monitor the location of animate entities more so than inanimate entities (like tools) that typically remained stationary. In other words, animate entities are capable of independent movement, can suddenly change course without warning, and occasionally initiate violent actions that result in destruction, injury, or death, all of which are argued to have contributed to an evolutionarily advantageous focus on animate entities.

While many cognitive and linguistic phenomena have been cited as showing the importance of animacy, animacy per se may not be the critical factor. *Natural forces* are semantically inanimate (nonliving), but behave in ways that are more similar to animates than inanimates in that they are able to initiate movement, change course without warning, and occasionally cause destruction, injury, and death. Accounts of evolutionary psychology cite extreme climate and natural disasters as important factors that likely shaped the prehistoric evolution of human behavior (Buss, 1991, 2009). Recorded history on supernatural beliefs found from classical mythology to modern religion provides ample evidence that humans are inclined to attribute volitional characteristics to inanimate forces of nature just as they do to animate entities (Guthrie, 1993). This suggests that cognitive focus may be guided by the perceived agency of an entity rather than its animacy, and further, that the cognitive potency of animate entities is not solely due to processes that vigilantly monitor the environment for unpredictable events but instead depends in very important ways on processes involved in creating causal explanations that are adaptive because they increase the predictability of events.

Analyses of language further indicate that this focus on the causal explanations of events is linguistically encoded in the basic processes that govern how subjects and verbs combine in sentences. Standard linguistic accounts (Chomsky, 1981) propose that a verb assigns thematic roles, which specify semantically how the arguments introduced by noun phrases combine with the actions introduced by the verb. For example, a verb like *injure* assigns the thematic role of “agent” to its subject, which requires that the subject be animate (1a). If instead the subject is inanimate (1b), it may still be possible to understand the sentence, but processing is made more difficult (Lowder & Gordon, 2012).

(1a) *The criminal injured the farmer in the field beside the barn.*

(1b) *The revolver injured the farmer in the field beside the barn.*

This difficulty with inanimate subject-verb integration may result from additional processing required in assigning a less-preferred *instrument* role to the subject (Cruse, 1973; Fillmore, 1968; Schlesinger, 1989). However, Dowty (1991) has argued that discrete thematic role categories, such as *agent* and *instrument*, should be replaced by the notion of a Proto-Agent. Under this account, the

Proto-Agent possesses the properties that are typically associated with thematic agents (i.e., volition, sentience, ability to change the state of another entity, movement), and a verb may assign an argument the Proto-Agent role to the extent that it resembles the prototype. Thus, it is possible for animate entities, natural forces, and instruments to participate in an event as Proto-Agents, but their degree of fit with this category may vary. From this perspective, the animacy of an entity referred to by a noun is less important than its *perceived agency*—the degree to which it is conceptualized as possessing the ability to initiate actions. A similar perspective comes from Wolff and colleagues (Wolff, Jeon, Klettke, & Li, 2010; Wolff, Jeon, & Li, 2009), who have proposed that the difficulty of interpreting a causal construction involving an inanimate subject depends on the entity’s inherent ability to generate its own energy. Under this account, inanimate entities lie on a *continuum of force creation*. On one end are natural forces (e.g., hurricanes, earthquakes, rivers), which are fully capable of creating their own energy. On the other end are instruments, tools, and weapons, which derive their energy from an animate agent, and therefore may not easily combine with an action verb.

Consistent with the notion that animacy influences the process of subject-verb integration, we have shown using eye-tracking that readers experience greater processing difficulty in sentences like (1b) than in sentences like (1a), where the action verb is the main verb of the sentence. However, when the action verb is embedded in a relative clause (1c & 1d), the animacy effect is substantially reduced (Lowder & Gordon, 2012).

(1c) *The criminal that injured the farmer was beside the barn.*

(1d) *The revolver that injured the farmer was beside the barn.*

This pattern of effects is important for several reasons. First, it demonstrates that semantic-thematic mismatches impose a processing cost. Second, it illustrates that this cost is mediated by sentence structure, which we argue directs the reader’s attention away from the relationships established in the relative clause and focuses the reader instead on the information asserted in the main clause (see also Lowder & Gordon, 2013, in press). Finally, and most critical to the current investigation, this pattern of effects suggests that this paradigm is particularly well-suited for examining the processing of different types of inanimate nouns.

The current experiment tests the hypothesis that natural forces are processed like animate nouns during subject-verb integration. Specifically, this hypothesis predicts that integration of an inanimate subject with an action verb is easier when the subject represents a natural force (e.g., tornado) than when it represents an instrument (e.g., revolver). In addition, if nouns referring to natural forces interact with sentence structure in the same way as do nouns referring to animate entities, then the difference between instruments and natural forces should be reduced by clausal separation as it is for inanimate and animate entities (Lowder & Gordon, 2012). This account predicts that instruments should cause greater processing difficulty

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