Title:
Remembering Generalizations: Memory Mechanisms Underlying the Generic Recall Bias

Abstract (913/1,000 words max):
Humans have the capacity to form generalizations that extend beyond their direct experience. Those generalizations can be expressed linguistically in different ways, most prominently through **generics** (e.g., “Dogs bark”), which make claims about kinds without specifying exact prevalence information, and **quantified statements** (e.g., “All/Most dogs bark”), which explicitly encode proportional information.

A large body of work suggests that generics are a privileged way of expressing generalizations, and indeed may reflect a cognitively default way of forming generalizations (Leslie, 2007, 2008). First, developmental studies have shown that across multiple, unrelated languages, young children understand generics at a younger age than quantified expressions (Hollander et al., 2002; Mannheim et al., 2010; Gelman & Tardif, 1998; Gelman et al., 2016), and parents commonly use generics but not quantifiers in child-directed speech (Gelman et al., 2000, 2014). Beyond child behavior, Leslie et al. (2011) demonstrate that adults often treat quantified expressions as generics in reasoning tasks. One striking phenomenon supporting the view that generics express a cognitively default way of generalizing is the **Generic Recall Bias (GRB):** quantified statements are more likely to be misremembered as generic than generic statements are to be misremembered as quantified, both in adults and children (Leslie & Gelman, 2012; Gelman et al., 2016; Sutherland et al., 2015).

Despite the robustness of the GRB, its underlying causes remain unclear: the bias could arise during encoding, from the loss of quantifier information over time, or at retrieval when a stored representation is recalled. The present research addresses this question using a two-session recall paradigm designed to dissociate these possibilities. Adults (N = 1,189) and young children (ages 4–9; *data collection ongoing*) completed versions of the same task; here, we focus on adults. Adults were randomly assigned to one of five language conditions (generic, all, most, some, or specific) and one of two memory conditions (immediate+delayed or delayed-only). All participants completed two sessions one week apart (**fig. 1**). In the first session, all participants completed a learning phase where they heard 16 statements about a novel social category (Zarpies) in their assigned language condition and 16 filler statements presented in the other language conditions. Participants then completed a distractor task. Those in the immediate+delayed condition were then asked to freely recall each statement from the learning phase; those in the delayed-only condition did not do any recall in the first session. In the second session, all participants were asked to recall the 16 Zarpies statements.

We identified three potential mechanisms that may lead quantified statements to be misremembered as generics. To accurately remember any given statement, you must (i) encode a representation into long-term memory, (ii) maintain the correct representation over time, and (iii) successfully retrieve this representation when prompted (Tulving & Thomson, 1973). The GRB could arise from any of these stages, leading to three hypothetical mechanisms:

(1) **Encoding**: When people hear a quantified statement, they encode a generic statement in long-term memory.
(2) **Retention**: While people successfully encode the quantified statement into long-term memory, they forget the quantifier over time and only the generic statement remains.
(3) **Retrieval**: When prompted to recall a quantified statement successfully preserved in long-term memory, people fail to retrieve the quantifier and report the generic.

Our experimental design teases apart these hypotheses. If the GRB is due to lapses during **encoding**, then participants who misrecall a quantifier as a generic during an immediate memory test should also misrecall it one week later. In other words, **encoding** predicts a trial-level correlation between items misrecalled as generic. Conversely, if the GRB is due to lapses in **retrieval**, then misrecalling a generic immediately should not predict whether it is misrecalled after a delay. Finally, if the GRB is due to **retention**, we should expect participants to misremember quantifiers as generics more often when tested one week later than when tested immediately.

Results

First, we found evidence for the GRB in a wider range of quantifiers than previously documented: in addition to a GRB for “all” and “most” previously documented in adults, we also found a GRB for “some”. Second, and more significantly, we isolated the underlying mechanism of the GRB. We found no significant evidence in support of **retention**: the magnitude of the GRB was not moderated by memory condition (*p*s > .13; see **figure 2**). Instead, the results supported **encoding** most clearly: there was high trial-level correlation between recall at the first and second sessions (92% agreement; 4,470 matched trials out of 4,860). As further support for **encoding**, participants who recalled correctly in the first session always recalled correctly in the second session (3,579/3,579 trials). Finally, as additional evidence against **retrieval**, those participants in a quantifier condition who misrecalled a generic in the first session never recalled the correct quantifier in the second session (0/615 trials).

Overall, these findings provide converging evidence that the Generic Recall Bias arises primarily at **encoding** rather than during **retention** or **retrieval**. This suggests that generics communicate a privileged representation for storing kind-level information

in memory, rather than a convenient linguistic shorthand at recall (see also, Gelman et al., 2016). In ongoing work, we extend our task to children to examine how this encoding bias develops across childhood. More broadly, the present longitudinal design offers a general framework for isolating the mechanisms underlying other asymmetric memory phenomena, such as the tendency to forget negations as affirmations rather than vice versa (Cornish & Wason, 1970; Maciuszek & Polczyk, 2017; Meyer, 1975). The present study thus serves as a proof of concept that progress can be made on the mechanisms underpinning longstanding cognitive phenomena.

Figures

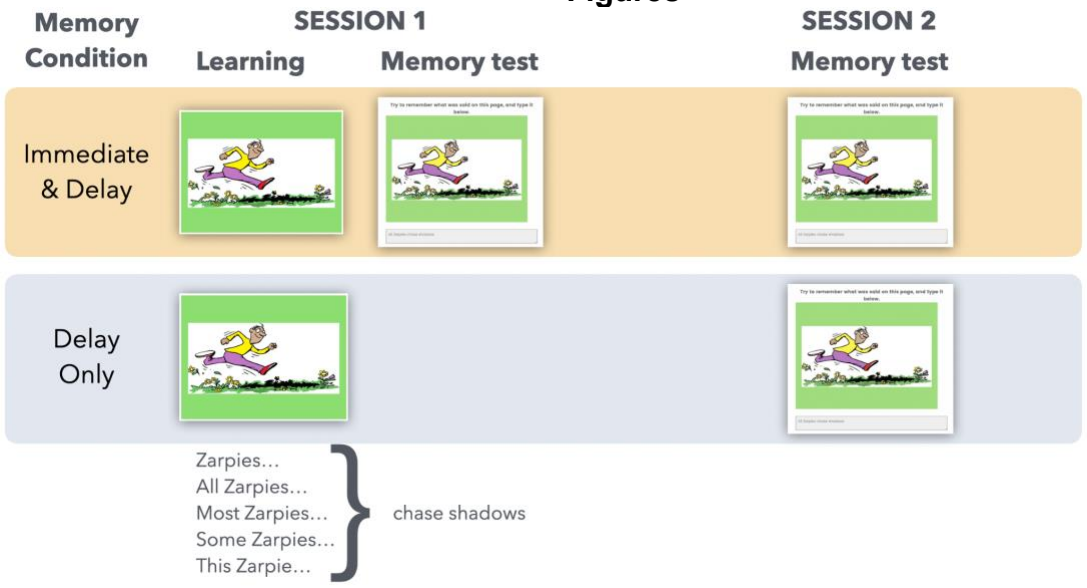

Figure 1. Schematic of our two-session recall paradigm. During a learning phase, participants hear 16 sentences about a novel social category (Zarpies) in one of five language conditions (GENERIC, ALL, MOST, SOME, SPECIFIC); they also hear 16 filler sentences. Then, after a brief distractor, participants in the IMMEDIATE+DELAY interval are given a memory test for what they remember. One week later, participants in both the IMMEDIATE+DELAY and DELAY ONLY interval return to take the memory test.

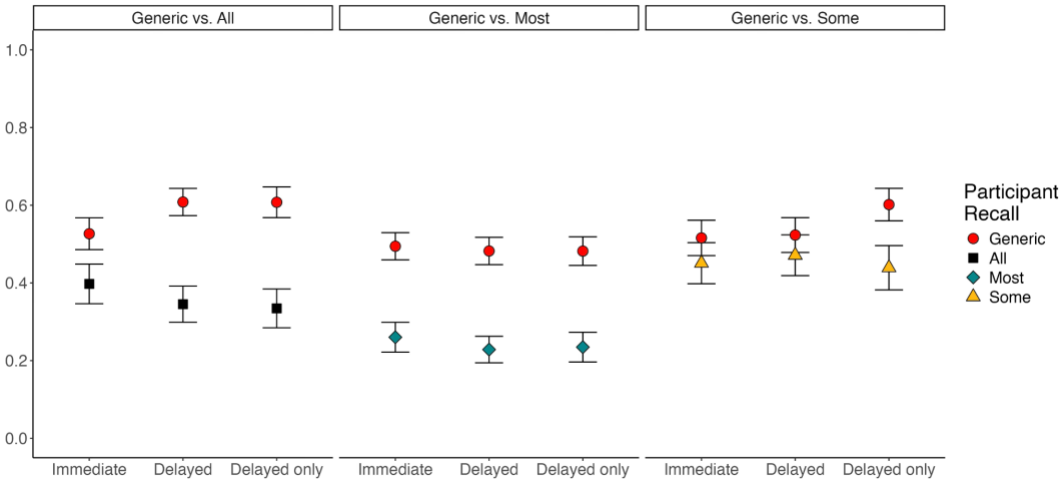

Figure 2. Adult recall mismatch by generic-quantifier comparison. Shapes represent predicted proportion mismatch (e.g., for Generic vs. All, recall *generic* in ALL condition and recall *all* in GENERIC condition); error bars are 95% confidence intervals. "Immediate" (*N* = 617), "Delayed" (*N* = 456) and "Delayed only" (*N* = 360) correspond to responses in the memory test sessions for the two memory conditions, "immediate+delayed" (in which participants were tested twice, one week apart) and "delayed only" (in which participants were tested once, a week after learning). All 456 participants in the "Delayed" condition (session 2) were the same participants from the "Immediate" condition (session 1).

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