The Sorites and the Generic Overgeneralization Effect

People deduce that there must be an exception to the induction step of the sorites:

Base step. One is a small number.
Induction step: Small numbers have small successors.
Conclusion: A billion is a small number.

Yet they are reluctant to concede that the nebulous exception constitutes refutation of the induction step. They confidently apply the generalization to any number you pick.

Recent work on the “Generic Overgeneralization Effect” suggests a psychological explanation of this loyalty to the induction step. Although the propounder of the sorites paradox intends the induction step to be a universal generalization, hearers assimilate universal generalizations to generic generalizations (for instance, ‘All birds fly’ tends to be remembered as ‘Birds fly’). Most generic generalizations permit exceptions – especially when those exceptions are rare, abnormal, or difficult to imagine. Any counterexample to the induction step will have all of these features. After all, sorites arguments are crafted to ensure a smooth ride down the slippery slope.

Some generic generalizations, such as ‘Whales are mammals’ forbid exceptions. Consequently there are sound slippery slope arguments that rely on generic generalizations: One billion is a large number. Large numbers have large successors. Therefore, two billion is a large number. My thesis is that generics enjoy psychological priority in conceptual slippery slope reasoning.

The generic reading is triggered even when the induction step is explicitly formulated as a universal generalization: For all n, if n is a small number, then n + 1 is a small number. To avoid suspicion that generalization is playing a dubious role in the sorites, some patient logicians formulate the argument as a sequence of conditionals: If 1 is a small number, then 2 is a small number. If 2 is a small number, then 3 is a small number. . . . But our assent to each conditional flows top-down from the background generic generalization: Small numbers have small successors. Belief in a generic disposes one to believe that an arbitrary member of a kind will have the relevant property
Reformulating the conditionals with other logical connectives does not break the hegemony of the generic. The material conditional ‘If p then q’ is truth-functionally equivalent to ‘Not p, or q’. But these truth-functional equivalents are not psychologically equivalent. Negations and disjunctions cause shakier performance. People reflexively grab the generic handrail. Each step down the slippery slope is discreetly guided by a generic generalization.

George Boolos (1991) notes that the induction step is implausible even apart from generating the absurd conclusion with the help of the base step. In addition to implying plausible conditionals such as ‘If 1 is small then 2 is small’, the induction step implies implausible conditionals such as ‘If 1 is small, then one billion is small’. Boolos wonders why we overlook these easy counterexamples to the induction step. My explanation is that we assimilate the induction step to the generic generalization ‘Small numbers have small successors’. Since the generic permits exceptions, it does not license a lengthy inference. So these counterexamples to the induction step do not come to mind. Our attention is restricted to a poorer field of candidates of the form ‘n is a small number but n + 1 is not a small number’.

For the classical logician, the correct way of thinking about the sorites is the way statistics instructors think about probability riddles. Like their students, the instructors cannot prevent the misconception that the riddle is designed to elicit. But the statistics instructors can override this gut reaction by applying expertise. Logic instructors only differ in not knowing whether to trust their expertise when the riddle is the sorites paradox. Are they rashly overextending classical logic? Does classical logic need to be revised or rejected?

Irreducibility of Generics

Early researchers tried to reduce generic generalizations to generalizations that are better understood at the theoretical level (for a heart-breaking review read The Generic Book). Their first pass was to analyze ‘Cheetahs run faster than cows’ as elliptical for ‘Most cheetahs run faster than cows’. But other generics, such as ‘Lions have manes’ are true
even when they hold for a minority of cases (only adult male lions have manes). And a
statistical generalization such as ‘Most books are paperbacks’ can be true without ‘Books
are paperbacks’ being true. Indeed, the generic ‘Sharks attack swimmers’ is true even
when less than 1% of sharks attack swimmers.

According to Gottlob Frege, quantifiers answer the question: ‘How many?’.

Generic sentences fail this test. One cannot answer ‘How many tigers are striped?’ by
replying ‘Tigers are striped’ (Carlson 1977). Instead of conveying numeric information,
generics characterize kinds. Generic generalizations are made true by their distinctive
prevalence, salience, and cautionary value.

The search for a more complicated numeric paraphrase has been undercut by
developmental psychology (Leslie 2007, 2008). Children understand generics before they
understand universal generalizations. So generics cannot be elliptical for universal
generalizations or statistical generalizations.

Daniel Everett (1995) claims that Piraha, a language spoken by a community in
the Amazon Basin, lacks formal quantifiers. Everett’s thesis is sharply contested
(Nevins, Pesetsky, and Rodrigues 2009). Even if false, however, Everett’s thesis raises
the interesting possibility that natural languages developed from languages that had only
generic generalizations.

The Generic Overgeneralization Effect

“The Generic Overgeneralization Effect (GOG) is the tendency to overgeneralize the
truth of a generic to the truth of the corresponding universal statement” (Leslie,
Khemlani, and Glucksberg 2011, 17). This is most noticeable in pre-schoolers
(Hollander, Gelman, and Star 2002; Leslie and Gelman 2012, experiment 4). Mandarin
pre-schoolers (Tardif, Gelman, Fu, and Zhu 2011) exhibit the same pattern of confusion.

Children must be trained to unequivocally wield universal generalizations and
statistical generalizations. Whereas universal generalizations and statistical
generalizations are marked by explicit quantifier words such as ‘All’, ‘No’, and ‘Most’,
no language has an explicit word for a generic quantifier (Dahl 1985). Since children
have great difficulty learning correlations with absences, this unmarked status is a sign of
an innate mechanism (Leslie 2008, 381).
Cognitive differences between adults and children diminish when adults are stressed. Adults under time pressure tend to misinterpret universals as generics (Meyer, Gelman, and Stilwell 2011). They revert to a generic interpretation because generics are easier to understand. This cognitive economy explains why generic interpretations are the default interpretations.

Like children, adults tend to misremember universal generalizations as generic generalizations (Leslie and Gelman 2012). S. A. Sloman (1998) reports that in a wide range of cases, subjects judge ‘All ravens are black’ as more likely than ‘All young jungle ravens are black’. Jönsson and Hampton (2006) have a charitable interpretation of this “inverse conjunction effect”. They hypothesize that subjects are slipping into a generic reading; maybe ravens are black but young jungle ravens are light brown!

The switch to the generic reading may be more than cognitive regression. For rhetorical effect, speakers overstate generic generalizations as universal generalizations. A hearer who downshifts universals to generics compensates for exaggeration.

The downshift also yields an advantage in cognitive economy. We save mental energy by substituting an easier task (evaluating a generic generalization) for a harder task (evaluating a universal generalization).

One might worry that this substitution drastically dilutes the content of the universal generalization. However, the loss is offset by a tendency to strongly generalize from generics. This inferential zeal is nicely reflected in the article title “Generic Statements Require Little Evidence for Acceptance but Have Powerful Implications” (Cimpian, Brandone, and Gelman 2010). Once you pick up a generic generalization you tend to wield it nearly as strongly as a universal generalization. Thus the two errors (treating an accepted universal as a generic and promiscuously inferring from a generic) tend to cancel out.

System 1 versus System 2

Innate systems are fast, effortless, and inaccessible to introspection. Instead of directly operating on statistical information, these systems react to how striking and significant the information is. This makes generic generalizations promising examples of default inferences.
The generics-as-default hypothesis comports with the “Two Systems” view of cognition set forth by Amos Tversky and Daniel Kahneman (Leslie 2007, 396). System 1 is the fast, automatic, effortless lower-level system. System 2 is the slower, effortful higher-level system governed by rules. Tversky and Kahneman (2002) use riddles to expose the rivalry between the systems: A bat and a ball cost $1.10 in total. The bat costs $1 more than the ball. How much does the ball cost? Most people intuit “10 cents”. That is the answer that springs to mind. Test-wise individuals stifle the answer. They calculate. Their algebraic reasoning is accessible to introspection: Since \( \text{Bat} + \text{Ball} = 1.10 \) and \( \text{Bat} = \text{Ball} + 1 \), \( \text{Ball} = .05 \).

Tversky and Kahneman argue that it is System 1 that underlies the inverse conjunction fallacy. After Sarah-Jane Leslie reviews these notorious deviations from probability theory, she traces generics to System 1:

The evidence surveyed so far suggests that System 1—the more primitive system—is not particularly sensitive to information about how much or how many. I suggest that generics are judgments issued by System 1. They are thus non-quantificational; they do not depend on considerations of quantity, or any such information easily captured by set-theory. They are, however, automatic, effortless, and cognitively basic. Quantifiers, in contrast, express judgments issued by System 2, the rule-governed, extension-sensitive, higher-level system. Quantifiers do depend on considerations such as how much and how many. They are thus easily describable in the terms of set-theory. (2007, 397)

The System 2 diagnosis of the sorites paradox is straightforward: the conjunction of the base step and the negation of the conclusion implies the existence of a small number that lacks a small successor, so the induction step is false. System 1 generates the intuition that the induction step survives proof of the notional exception. After all, ‘Small parents have small children’ survives concrete proof that some small parents have produced tall children. System 2 is reacting to an abstract proof that there is a single, unspecifiable exception to ‘Small numbers have small successors’.
The provenance of intuitions is relevant to how carefully we must heed them. If persuaded that the loyalty to the induction step is due to System 1 then the reader is more apt to override the intuition with System 2 calculations.

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References
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