Pragmatic constraints and pronoun reference disambiguation: the possible and the impossible

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April 6, 2022

Abstract

Pronoun disambiguation in understanding text and discourse often requires the application of both general pragmatic knowledge and context-specific information. In AI and linguistics research, this has mostly been studied in cases where the referent is explicitly stated in the preceding text nearby. However, pronouns in natural text often refer to entities, collections, or events that are only implicitly mentioned previously; in those cases the need to use pragmatic knowledge to disambiguate becomes much more acute and the characterization of the knowledge becomes much more difficult. Extended literary texts at times employ both extremely complex patterns of reference and extremely rich and subtle forms of knowledge. Indeed, it is occasionally possible to have a pronoun that is far separated from its referent in a text. In the opposite direction, pronoun use is affected by considerations of focus of attention and by formal constraints such as a preference for parallel syntactic structures; these can be so strong that no pragmatic knowledge suffices to overrule them.

1 Semantics, context, and pronoun disambiguation

It is well known that pronoun disambiguation in understanding text and discourse often requires the application of both general pragmatic knowledge and context-specific information (Rohde, 2018).

The point is vividly illustrated by Winograd schemas (Levesque, Davis, and Morgenstern 2012) such as the well-known example,

The trophy doesn’t fit in the brown suitcase because it is too big.
The trophy doesn’t fit in the brown suitcase because it is too small.

In the first sentence the pronoun it must refer to the trophy; in the second, it must refer to the suitcase. The sentences differ only in the final words big and small, so that distinction, and the relation of the size of two objects to the possibility of fitting one inside the other, must be determining the referent of the pronoun.

Similarly, consider the pair of sentences

Joan made sure to thank Susan for all the help she had given.
Joan made sure to thank Susan for all the help she had received.
In the first sentence the referent of *she* is Susan, whereas in the second the referent is Joan, reflecting the fact that someone who receives help thanks someone who gives it.

Current natural language processing technology is able to achieve high levels of success on collections of these kinds of examples (Kocijan et al. 2022) by using the patterns of word associations extracted by deep learning networks as proxies for this kind of underlying knowledge. But there is no question that people, in understanding these texts, are drawing on a deep knowledge of the world (Lake and Murphy, 2020) and, I would argue, little doubt that, in the long run, truly intelligent AI systems will need to do likewise.

The above sentences can be expanded to make the issues of pronoun disambiguation more complex while keeping them well-formed and intelligible.

I tried packing the trophy in the brown suitcase, but it was too large, and I couldn’t close it. So instead I’ll get the red suitcase, because it should be large enough that it will fit in it.

Joan made sure to thank Susan for all the help she had given her when she had been in trouble. Her generosity and sympathy had made an enormous difference to her.

More complex examples are possible:

Mary White called Susan Brown to let her know that her daughter Jennifer had come over after school to the Whites’ house to play with their own daughter Edith. She thanked her for calling, because she had really started to wonder why she hadn’t come home.

Both AI and linguistic analysis have focused on short texts like the above, for ease of analysis; but in extended texts, the complexities of reference and the subtlety of the knowledge needed for disambiguation can be much greater. For example, the following passage occurs in part 2, chapter 2 of Jane Austen’s *Emma*. Four female characters are involved: Emma Woodhouse, Jane Fairfax, Jane’s aunt Miss Bates, and Miss Bates’ mother. The dinner party also includes at least Emma’s father and Mr. Knightley. I have put personal pronouns in bold face, for emphasis

Upon the whole, Emma left her [Jane Fairfax] with such softened, charitable feelings, as made her look around in walking home, and lament that Highbury afforded no young man worthy of giving her independence; nobody that she could wish to scheme about for her.

These were charming feelings — but not lasting. Before she had committed herself by any public profession of eternal friendship for Jane Fairfax, or done more towards a recantation of past prejudices and errors, than saying to Mr. Knightley, “She certainly is handsome; she is better than handsome!” Jane had spent an evening at Hartfield with her grandmother and aunt, and every thing was relapsing much into its usual state. Former provocations reappeared. The aunt was as tiresome as ever; more tiresome, because anxiety for her health was now added to admiration of her powers; and they had to listen to the description of exactly how little bread and butter she ate for breakfast, and how small a slice of mutton for dinner, as well as to see exhibitions of new caps and new workbags for her mother and herself

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1I am told that readers who encounter this out of the context of the novel find some of these pronouns hard to resolve.
and Jane’s offences rose again. **They** had music; Emma was obliged to play; and the thanks and praise which necessarily followed appeared to **her** an affectation of candour, an air of greatness, meaning only to shew off in higher style **her** own very superior performance. **She** was, besides, which was the worst of all, so cold, so cautious!

Some of these disambiguations are straightforward, some quite subtle. Teasing out all the forms of knowledge that are used in all these disambiguations would require a lengthy analysis. However, I note that the fact that the narrative is given from Emma’s point of view — a fact about narrative structure — is important in disambiguating “appeared to her” in the second to last sentence.

### 2 Antecedents that are entirely missing

There are also a number of cases where a third-person pronoun can be used with no antecedent noun phrase. Some of these are natural, some are literary. Cases II and III are common and established enough that they are listed in the Oxford English Dictionary as distinct meanings of **they**.

I. A pronoun may refer to an action or event that appears as a verb phrase. E.g. in “John hiked for three hours but it tired him out” the word **it** refers to the hike.

II. **They** can mean people in general or some implicit collection of people. Sometimes **they** is just equivalent to “Some people” as in “They say that a shot of whiskey is good for a cold.” But often it refers to a specific collection of people which much be inferred from context. For instance, in “I went to the hospital but they told me to go home”, **they** refers to the hospital staff. In the earlier quotation from *Emma*, in the phrase “they had to listen” the word **they** refers to everyone at the dinner other than Miss Bates herself; in the phrase “They had music”, it refers to everyone at the dinner. Neither group is otherwise named here by a noun phrase.

This is possible even when there are other possible antecedents and other occurrences of **they**. “Jack and Otto went to the hospital, but they told them to go home.”

However, there are limits to this; it would be a stretch to say, with no antecedent (***) I went to the park and they were all enjoying the pleasant spring weather.

It would be impossible to say (***) Between January 2020 and March 2021, more than 2,500,000 of them died of Covid-19.

(I use the linguists’ convention of marking anomalous sentences with an asterisk.)

In the Ira Gershwin lyric, “The way you wear your hat / The way you sip your tea / The memory of all that / No, no, they can’t take that away from me,” the phrase **they** can’t means “No one can”.

The first-person plural pronoun **we** and the second-person pronoun **you**, which generally have no antecedent, raise similar issues. **We** refers to some collection of people that includes the speaker; **you** refers to some collection of people being addressed; but which particular collection has to be determined from context, and indeed is often deliberately vague.

III. The Oxford English Dictionary gives as one definition of the word **they**. “People in authority collectively, regarded as impersonal and oppressive” (OED). A couple of illustrative examples:

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2 Also subtle is the identification of Jane as the speaker of those thanks and praise that seemed to Emma an affectation of candor. Presumably everyone at the dinner party gave Emma thanks and praise for her playing, but it was only Jane’s that she found affected.
quotes:
“English political thinking is much governed by ‘they’. ‘They’ are the higher-ups, the mysterious powers.” — George Orwell.
“They really have to do something about all the potholes in this city.”

IV. The protagonists of a poem or short story (e.g. “Stories” by I.L. Peretz) may be denoted throughout by he and she for literary effect. An extreme example is the novel, Wolf Hall, by Hilary Mantel, in which the protagonist, Thomas Cromwell, is always denoted as he and never named; but this at times becomes hard for the reader to follow.

V. There is a literary trope in which characters or the narrator use pronouns without need for antecedent to refer to powerful, malevolent figures whose name is either unknown or dangerous to speak: for instance, human beings in Bambi, or Queen Ayesha in Rider Haggard’s novel She. In J.R.R. Tolkien’s The Two Towers, Pippin says “Then he came” (italics in the original) without antecedent to mean Sauron in describing their encounter through the Palantir. In Conan Doyle’s The Valley of Fear, Porlock writes, “Dear Mr. Holmes, I will go no further in this matter. It is too dangerous — he suspects me,” he being Professor Moriarty. In the case of they this often combines with (III): “I suppose you mean we ought to spend all our time sucking up to Them, and currying favour, and dancing attendance on Them like you do.” (C.S. Lewis, The Silver Chair). In this usage, the pronoun tends to be typographically marked: put in quotation marks, or italicized, or capitalized, presumably to be read aloud to a particular emphasis — the quote from The Valley of Fear is an exception. It is more common in direct quotation than in narration — Haggard’s She is an exception.

3 Demonstrative pronouns referring to a category

Somewhat similar to the ambiguity of “we” and “they” discussed above, it is possible to use the pronouns “this” and “that” in such a way that, though the grammatical antecedent is a specific individual or event, the actual semantics is some category that includes the individual. Such cases are often ambiguous, and if they can be disambiguated, they require pragmatic constraints.

I have not found any examples in literature, but here is an artificial example.

Joe was way behind on the programming project for his operating systems course, and it was due the next day, so he turned off his phone and stayed up all night finishing it. He had never done that before.

What exactly had Joe never done before?

1. Stayed up all night?
2. Stayed up all night doing school work?
3. Stayed up all night doing a programming project (either for a course or for fun)?
4. Stayed up all night doing a course for this particular class? or doing this specific project?

1′–4′. Turned off his phone and [1–4]?

Thanks to Doug Hofstadter for bringing this to my attention.
4 Excluded forms

There are limits on the ways in which a pronoun is allowed to connect to a referent, even when pragmatic constraints decisively rule out any other possible referent, as the examples in table 1 demonstrate:

1. * The trophy doesn’t fit in the suitcase, because the trophy is an awkward shape and it is too small.
2. * When Joan broke her leg, Susan had given her a lot of help, but Mary had not bothered to ask after her. She had been very generous.
3. * Ann has two sons. Barbara has no children. Her children are in elementary school.
4. * Robert woke up at 9:00 AM, while Samuel woke up at 6:00 AM, so he had more time to get ready for school.
5. * Robert woke up at 9:00 AM, but Samuel woke up at 6:00 AM, so he had less time to get ready for school.
6. * The child was screaming after the baby bottle and toy fell. Since he was full, it stopped his crying.

Table 1: Pronoun references in which pragmatic constraints do not disambiguate

(Examples 4 and 6 are from Sakaguchi et al., 2020.) Semantically, it in (1) must refer to the suitcase; she in (2) must refer to Susan; her in (3) must refer to Ann; he in (4) must refer to Samuel; he in (5) must refer to Robert; and it in (6) must refer to bottle — at least, that is the consensus of the crowd workers who created (6) and the other crowd workers who endorsed it. To my ear, 2, 3, 4, and 6 are completely impossible; and 1 and 5 is at best extremely unnatural.

Note that, (4) and (5) are fine with the conjunctions reversed:

4† Robert woke up at 9:00 AM, but Samuel woke up at 6:00 AM, so he had more time to get ready for school.
5† Robert woke up at 9:00 AM, while Samuel woke up at 6:00 AM, so he had less time to get ready for school.

Adding a number-agreement constraint fixes (1), and adding gender-agreement constraints fixes (4) and at least helps in (5), but neither gender nor number constraints help in (2) or (3) (table 2).

The question is, why are sentences (1-6) excluded whereas the examples discussed earlier — much more complex in structure, much less decisive in their pragmatic constraints — acceptable?

It seems plausible to conjecture that to some extent the issue here is one of narrative focus. The conjecture would be that there a rule that the referent of a pronoun must be sufficiently in focus in the narrative. Because of the syntactic form of the texts, in sentences 1-6 the referents that are pragmatically possible (the suitcase, Susan, Ann, Samuel, Robert, and the bottle, respectively) are out of focus, and therefore the reference is impossible.

However, this is obviously largely explanation of *ignotum per ignorantem*; without a mechanism for determining what the objects in focus at any point in a text, this raises more questions

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4I am just using my own “linguistic intuition”; I have not checked this with empirical studies.
1'. The trophies don’t fit in the suitcase, because they are an awkward shape and it is too small.

2'. * When Joan broke her leg, Susan had given her a lot of help, but Bob had not bothered to ask after her. She had been very generous.

2''. * When Joan broke her leg, the Millers had given her a lot of help, but Bob had not bothered to ask after her. They had been very generous.

3'. * Ann has two sons. Fred has no children. Her children are in elementary school.

3''. * Ann and David have two sons. Barbara has no children. Their children are in elementary school.

4'. Robert woke up at 9:00 AM, while Sarah woke up at 6:00 AM, so she had more time to get ready for school.

5'. ? Robert woke up at 9:00 AM, but Sarah woke up at 6:00 AM, so he had less time to get ready for school.

Table 2: Pronoun references with gender and number constraints. These do not always disambiguate.

than it answers. Why does the semantically vacuous difference between (4) and (5) in table[1] so entirely change the focus? How is it that, in the passage from *Emma*, Emma, Jane, and Miss Bates all remain sufficiently in focus that a pronoun can refer to any of them? If there is such a rule of focus involved in the variants of sentence (1), why do the constraints of number agreement easily suffice to overrule it, while the pragmatic constraints do not?

Kehler (2015) similarly gives a number of examples where the form of the sentence either forces a pragmatically implausible reading or conflicts with pragmatics in a way that makes the sentence unintelligible. (Kehler carried out tests with human subjects to confirm his intuitions.)

(a) The demonstrators were denied a permit by the city council because they feared violence.

(b) The city council denied the demonstrators a permit because they felt strongly that the best way to draw attention to current political issues is to advocate violence.

(c) Norm lent his car to his brother’s girlfriend. He doesn’t own one.

(d) Margaret Thatcher admires Hillary Clinton, and George W. Bush absolutely worships her.

In (a) readers generally interpret *they* as referring to the demonstrators. In (b) readers “garden path”: they initially interpret *they* as meaning “the city council” and then consciously backtrack and correct when they reach the end of the sentence. In (c) readers end up confused rather than deciding that *he* refers to the brother. In (d) readers interpret *her* as meaning Clinton rather than Thatcher, despite the fact that, when the example was devised, Thatcher was much more plausible. In cases (a), (b), and (d), readers are letting syntactic parallelism trump pragmatic plausibility. In (b), in contrast to Winograd’s original example, presumably the distance between *they* and the disambiguating “advocate violence” is so large that readers cannot suspend judgement, so they go with the syntactically parallel reading and then withdraw it. (Why (b) leads to garden-pathing whereas (c) and (d) just lead to puzzlement is not at all clear.)

Rohde (2018) proposes a Bayesian framework for pronoun reference disambiguation: probabilities based on the form of the sentence are combined with probabilities derived from pragmatic considerations as dictated by Bayes’ law. The cases that we have considered are not inconsistent with a Bayesian framework — very little is, if you adopt the right framework and set the priors properly (Davis, 2013) — but they are certainly an awkward fit. One would have
supposed that the assumption that a sentence is meaningful has a strong prior; that the pragmatic constraints in these sentence have very strong priors (e.g. the probability that Barbara both has no children and that her children are in elementary school is zero); and that the probabilities associated with these rather nebulous considerations of focus would be comparatively indeterminate. Apparently, that is not the case.

5 Remote pronoun antecedents in literature

In literature it is occasionally possible to use pronouns whose nearest antecedent occurs much earlier, outside the categories of section 2.

There is a remarkable instance in Dickens’ *David Copperfield*. In chapter 31, Steerforth seduces Emily and flees with her. Steerforth is mentioned again, in passing at the beginning of chapter 34 (p. 474 in my copy). Steerforth is unmentioned in chapters 35-39. In chapter 40, Mr. Peggotty meets with David Copperfield and describes his search in Europe for Emily; in this entire chapter there is only one mention of Steerforth, by a pronoun: “He was nowt to me now.” (p. 566; italics in the original). The next mention after that is in chapter 46 (p. 645):

“Pray, has this girl been found?
“No.”
“And yet she has run away!”
“Run away?” I repeated
“Yes! From him,” she said with a laugh.

Another example is from Dickens’ *Bleak House*:

“Jo,” repeats Allan, looking at him with attention, “Jo! Stay. To be sure! I recollect this lad some time ago being brought before the coroner.”

“Yes, I see you once afore at the inkwhich,” whimper’s Jo. “What of that? Can’t you never let such an unfortnet as me alone? An’t I unfortnet enough for you yet? How unfortnet do you want me fur to be? I’ve been a-chivied and a-chivied, fust by one on you and nixt by another on you, till I’m worritted to skins and bones. The inkwhich warn’t MY fault. I done nothink. He wos verry good to me, he wos; he wos the only one I knewed to speak to, as ever come across my crossing.”

*He* in the last sentence refers to the subject of the coroner’s inquest, Captain Hawdon, who has not been mentioned since chapter 40. Hawdon is an important figure in the back-story, being the unknown father of the first-person protagonist Esther Summerson, but a rather minor figure in the novel as a whole; and many male characters are mentioned between chapters 40 and 46.

However, the identification presents no difficulty, either for Allan Woodcourt or for the reader. The context of the inquest would probably suffice, but additionally, in chapter 11, which describes the inquest, Jo uses the identical phrase “He wos verry good to me, he wos,” there unambiguously of Hawdon, and Dickens marks it by repeating it at the end of the chapter.

A third example is from *At Swim-Two-Birds* by Flann O’Brien:

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It would probably be frowned on in other forms of writing.
On the morning of the third day thereafter, said Finn, he was flogged until he bled water.

The referent of *he* is a hypothetical “man who mixed his utterance with the honeywords of Finn”. Finn is continuing his own train of thought, which in the novel has been interrupted for two pages by an unrelated conversation between two other people. The distance is much shorter, but the referent is even more minor, and, unlike the quotes from Dickens, is completely unrelated to the immediate context.

It can be objected that all three is in direct quotation, and anything is permitted in direct quotation. However, at least with the quotation from *Bleak House*, if we modify the passage to take it out of direct quotation, the reference remains clear, though certainly the literary quality suffers:

“Yes, I see you once afore at the inkwhich,” whimpers Jo. “What of that? Can’t you never let such an unfortnet as me alone? An’t I unfortnet enough for you yet? How unfortnet do you want me fur to be? I’ve been a-chivied and a-chivied, lust by one on you and nixt by another on you, till I’m worritted to skins and bones. The inkwhich warn’t MY fault. I done nothink.” Jo continues to whimper that he had been very good to Jo; he was the only person who came across Jo’s crossing that Jo had known to speak to.

(It would be hard to recast the quotes from *David Copperfield* or *At Swim-Two-Birds* in this way.)

More importantly for our purposes, in all three cases, the reader identifies the reference, and the expression does not seem unnatural. They are not problematic in the manner of the starred sentences in section 4.

Narrative focus is clearly relevant in the quotes from *David Copperfield*, where Emily is the subject, and in *Bleak House*, where the inquest is the subject. The immediate context is entirely irrelevant in *At Swim-Two-Birds*; the effect is startling and humorous. That is a much smaller gap, so the reader still has in mind Finn’s previous conversation.

The most striking kind of example of this kind would be the use of *he* or *she* by the narrator a significant distance from the last mention of the person, in some fairly straightforward narrative text. I expect that such examples exist, but there is no easy way to search for them.

6 Conclusion

These kinds of phenomena have been studied in linguistics, but, as far as I have found, only in disambiguating third person pronouns, only with short texts, and only when the possible antecedents are given explicitly. It has been unstudied in AI studies of text interpretation, because those are concerned with texts that do arise, not with explaining why impossible texts cannot arise; and in AI studies of text generation, because a generator that is conservative in its use of pronouns can easily avoid the issue. It does become significant when one is involved in creating a data set of hard pronoun-resolution problems, because then one has to deliberately skate close to the rather fine line that separates pronoun usages that are difficult for an AI to resolve from pronoun usages in these ways; and it is important that all the texts in a dataset

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6 *At Swim-Two-Birds* is anything but straightforward narrative, and *Bleak House* has a somewhat unusual narrative form, but their complexities are not relevant to this issue.
are clearly proper usage (Kocijan et al. 2022). The phenomenon is in any case a curious one, and an adequate explanation might well shed some light on larger questions of how pronouns are used and understood.

Acknowledgements

Thanks to Yuling Gu, Doug Hofstadter, Andrew Kehler, and Leora Morgenstern for helpful discussions.

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