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How do Mandarin speakers interpret implausible sentences? In our new paper in Cognitive Science (w/ @zhanmeilin @roger_p_levy Jiayi Lu @LanguageMIT), we model Mandarin speakers' interpretation using a noisy-channel framework. Paper link: onlinelibrary.wiley.com/doi/10.1111/co.... A thread 1/10

Rational Sentence Interpretation in Mandarin Chinese

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Abstract

Previous work has shown that English native speakers interpret sentences as predicted by a noisy-channel model: They integrate both the real-world plausibility of the meaning —the prior—and the likelihood that the intended sentence may be corrupted into the perceived sentence. In this study, we test the noisy-channel model in Mandarin Chinese, a language taxonomically different from English. We present native Mandarin speakers sentences in a written modality (Experiment 1) and an auditory modality (Experiment 2) in three pairs of syntactic alternations. The critical materials are literally implausible but require differing numbers and types of edits in order to form more plausible sentences. Each sentence is followed by a comprehension question that allows us to infer whether the speakers interpreted the item literally, or made an inference toward a more likely meaning. Similar to previous research on related English constructions, Mandarin participants made the most inferences for implausible materials that could be inferred as plausible by deleting a single morpheme or inserting a single morpheme. Participants were less likely to infer a plausible meaning for materials that could be inferred as plausible by making an exchange across a preposition. And participants were least likely to infer a plausible meaning for materials that could be inferred as plausible by making an exchange across a main verb. Moreover, we found more inferences in written materials than spoken materials, possibly a result of a lack of word boundaries in written Chinese. Overall, the fact that the results were so similar to those found in related constructions in English suggests that the noisy-channel proposal is robust.

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The noisy-channel framework proposed in previous studies (e.g. Levy, 2008; Gibson et al., 2013) models how comprehenders interpret sentences. The comprehender, given a perceived sentence s_p, tries to recover the speaker's intended sentence s_i. 2/10
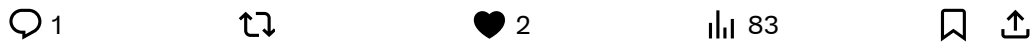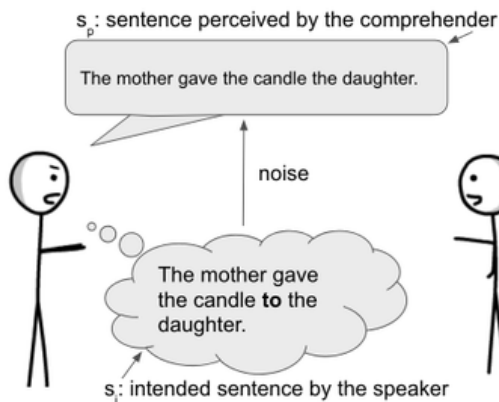
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They do so by considering two quantities: 1) p(s_i): the prior, so that s_i was intended literally, and 2) how likely does the intended sentence change into the perceived sentence p(s_i -> s_p). You can see a more detailed illustration here: x.com/cshnican/statu... 3/10

> 🌄 **Sihan Chen** @cshnican · Jun 18
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> Replying to @cshnican
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> The noisy-channel framework has been used to model how people interpret implausible sentences: people do so based on how likely the intended sentence is and how likely it is to be corrupted into the implausible one by noise. 2/11
>
> s_p: sentence perceived by the comprehender
>
> The mother gave the candle the daughter.
>
> noise
>
> The mother gave the candle **to** the daughter.
>
> s_i: intended sentence by the speaker
>
> $$p(s_i \mid s_p) \propto p(s_i) * p(s_i \to s_p)$$
>
> $p(s_i \mid s_p)$: how likely is the sentence to be s_i, when the comprehender perceives s_p;
>
> $p(s_i)$: how likely is the intended sentence to be talked about; how likely is the structure in the intended sentence to be used.
>
> $p(s_i \to s_p)$: how likely is the intended sentence to result in the perceived sentence, as a result of noise; a high $p(s_i \to s_p)$ means that a type of noise operation is very likely to happen.

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Previous studies investigating the NC sentence-processing framework have mainly been done in English (with one recently by @moshepoliak et al. in Russian). In our study, we tested the framework in Mandarin Chinese, a language taxonomically different from English and Russian. 4/10

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Our test sentences are under three syntactic alternations: active/passive, direct-object (DO) / serial-verb, and transitive/intransitive. We consider four noise operations: insertion, deletion, exchange across a main verb, and exchange across a function word. 5/10


Plausible active:	Exchange across main verb →	Implausible active:
奶奶 打碎 了 这 个 碗 Grandma break-ASP this-CL bowl "Grandma broke the bowl"		这 个 碗 打碎 了 奶奶 This-CL bowl break-ASP Grandma "The bowl broke grandma"
Plausible passive:	Exchange across function word →	Implausible passive:
这 个 碗 被 奶奶 打碎 了 This-CL bowl **bei** grandma break-ASP "This bowl was broken by Grandma"		奶奶 被 这 个 碗 打碎 了 Grandma **bei** this-CL bowl break-ASP "Grandma was broken by this bowl"
Plausible DO:	Insertion →	Implausible serial verb:
老林 付 了 清洁工 五十块 钱 Laolin pay-ASP cleaner fifty-CL money "Laolin paid the cleaner 50 Yuan."		老林 付 了 清洁工 给 五十块 钱 Laolin pay-ASP cleaner **gei** fifty-CL money "Laolin paid the cleaner to 50 Yuan."
Plausible serial verb:	Deletion →	Implausible DO:
老林 付 了 五十块 钱 给 清洁工 Laolin pay-ASP fifty-CL money **gei** cleaner "Laolin paid 50 Yuan to the cleaner."		老林 付 了 五十块 钱 清洁工 Laolin pay-ASP fifty-CL money cleaner "Laolin paid 50 Yuan the cleaner."
Plausible transitive	Exchange across main verb →	Implausible transitive
清水 溶解 了 食盐 Clear-water dissolve-ASP salt "The clear water dissolved the salt."		食盐 溶解 了 清水 Salt dissolve-ASP clear-water "The clear water dissolved the salt."
Plausible intransitive	Exchange across function word →	Implausible intransitive
食盐 在 清水 里 溶解 了 Salt **zai** clear-water **li** dissolve-ASP "The salt dissolved in the clear water."		清水 在 食盐 里 溶解 了 Clear-water **zai** salt **li** dissolve-ASP "The clear water dissolved in the salt"

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Results: Comprehenders are 1) less likely to literally interpret implausible sentences than plausible sentences. 2) less likely to literally interpret sentences made implausible by deletions/insertions than those made implausible by exchanges. Both consistent with past work. 6/10

Experiment 1

Experiment 2
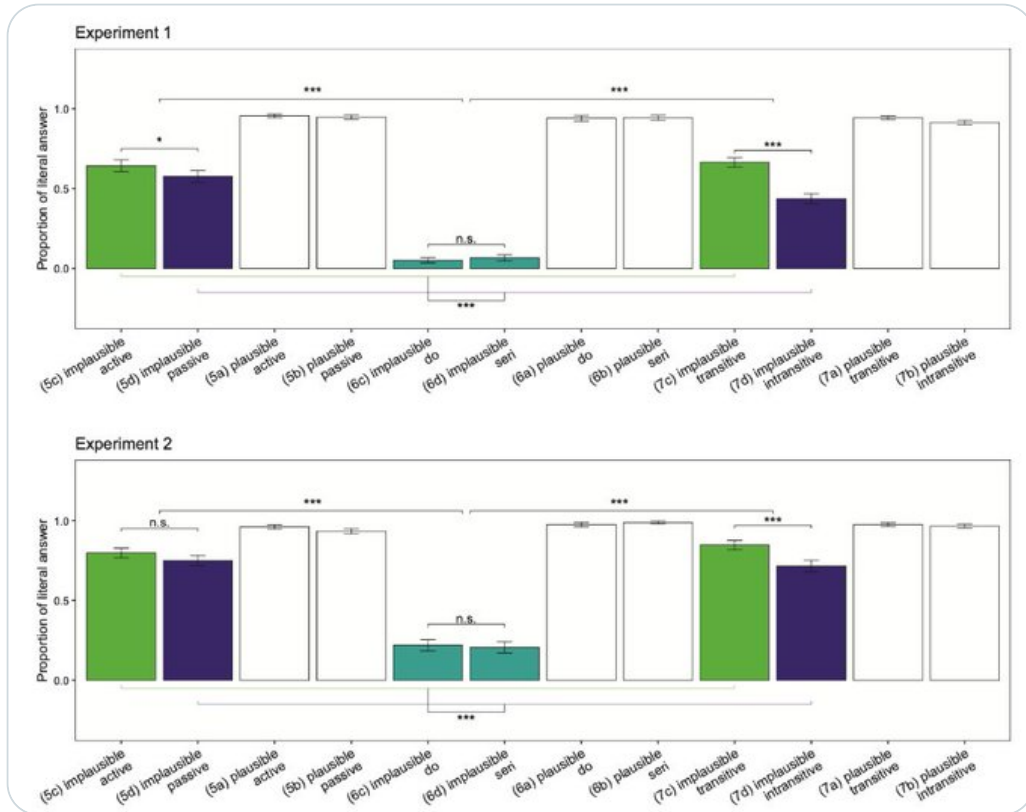
Q 1   ↻   ♥ 2   ili 48   🔖 ↥

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Within sentences made implausible by exchanges, we also found those by exchanges across a function word are less likely to be interpreted literally than those by exchanges across a main verb, consistent with the Garrett (1985) that local noise operations are more likely. 7/10

Q 1   ↻   ♥ 2   ili 38   🔖 ↥

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Interestingly, we did not see the same results in DO/serial-verb sentences as in Gibson et al. (2013), as the literal interpretation rate is similar in DO and serial-verb sentences. This was possibly because people inferred a plausible alternative that we did not intend. 8/10

Inferred plausible sentence:	Deletion	Implausible serial verb:
老林 付 了 清洁工 **给 了** 五十块 钱 Laolin pay-ASP cleaner **give-ASP** fifty-CL money	⇨	老林 付 了 清洁工 **给** 五十块 钱 Laolin pay-ASP cleaner **gei** fifty-CL money
"Laolin paid the cleaner **and gave** (the cleaner) 50 Yuan."		"Laolin paid the cleaner **to** 50 Yuan."

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We replicated our experiment in the auditory modality (Exp2), where all the conditions remained the same except participants listened to the test sentences instead of reading them. We still got largely the same results except a higher overall literal interpretation rate. 9/10

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our results suggest noisy-channel inference is not language-specific - speakers of other languages also interpret sentences in a rational manner, and not modality-specific - we've tested this both in reading and listening and got similar results. 10/10

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