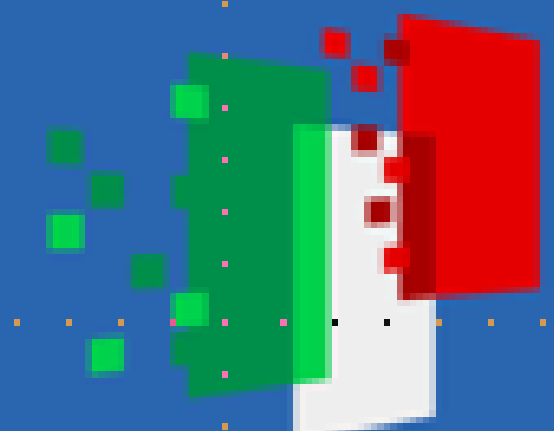


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# Understanding the 1-in-X format effect in risk communication

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## Abstract

The 1-in-X bias occurs when individuals perceive probabilities as higher when presented in the "1-in-X" format (e.g., 1 in 50) compared to "N-in-NX" format (e.g., 20 in 1000), despite being equivalent. This study explores two explanations for the bias: empathy and availability. Results from ten preregistered experiments support the availability heuristic as the main explanation for the bias.

## Aim

The 1-in-X overestimation is consistently observed across diverse populations, probabilities, outcomes, domains and different individual differences (e.g., Pighin et al., 2024). However a definitive explanation has remained elusive. In a series of 10 preregistered experiments we **tested two explanations**:

- **The emphatic explanation**: 1-in-X induces more emphatic reactions than N-in-NX
- **The availability heuristic explanation**: 1-in-X makes it easier to think or imagine examples where the ratio applies compared to N-in-NX

## Typical scenario

Imagine that you are told there is a [1 in 50 / 20 in 1000] chance of contracting the Disease X. In your opinion, this chance is:

○ ○ ○ ○ ○ ○ ○  
*Extremely Low* *Extremely High*

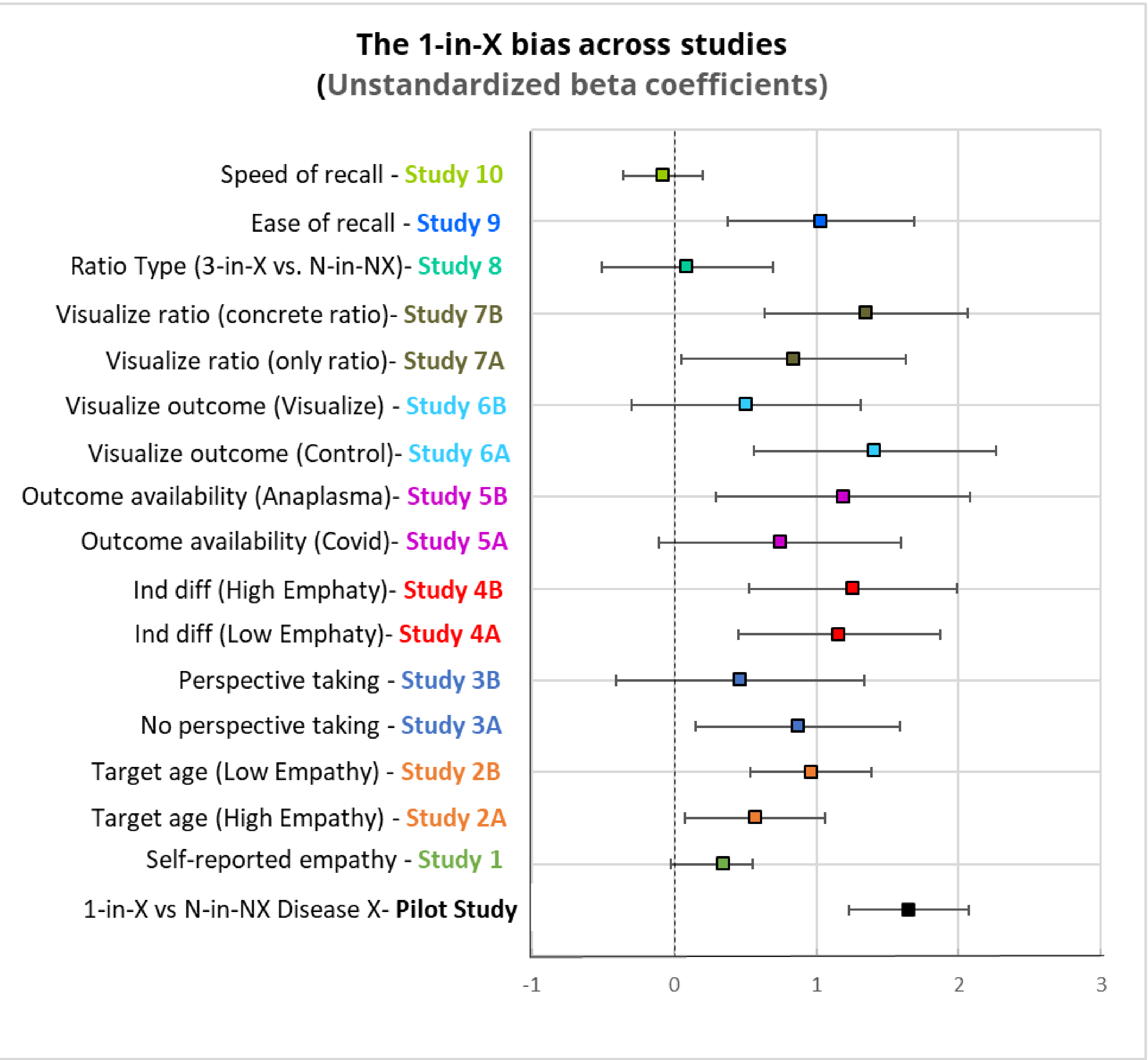
## Overview of Studies

Study	Explanati on Tested	Manipulatio n / Moderator	Dependen t Measure	N	1-in-X Effect	Moderator Effect	Key Result
Pilot	1inX effect	none	Subj. probability (1-7)	176	●		1-in-X > N-in-NX
1	Empathy	Self-reported empathy (8- item IRI; Davis, 1980)	Empathy (1-7)	185	●		empathy 1-in-X = empathy N-in-NX
2	Empathy	Target age (younger vs older adult)	Subj. probability (1-7)	342	●	●	Bias present; empathy ns
3	Empathy	Perspective- taking (write sentence)	Subj. probability (1-7)	140	●	●	Bias present; empathy ns
4	Empathy	Individual differences (full IRI)	Subj. probability (1-7)	144	●	●	Bias present; empathy ns
5	Availability	Outcome availability (COVID-19 vs Anaplasma)	Subj. probability (1-7)	125	●	●	Bias present; outcome availability ns
6	Availability	Visualization task (imagine group of people)	Subj. probability (1-7)	126	●	●	Bias present; outcome availability ns
7	Availability	Concreteness (abstract vs concrete ratios)	Ease of mental visualizatio n (1-7)	125	●	●	1-in-X ratio easier to visualize; concreteness ns
8	Availability	Ratio type (3- in-X vs N-in- NX)	Ease of mental visualizatio n (1-7)	128	●		Effect specific to 1-in-X
9	Availability	Recall task (thinking of examples)	Ease of recall (1-7)	128	●		1-in-X → easier recall
10	Availability	Recall latency	Response time (ms)	177	●		No latency difference

## Notes

**Study 1:** Example item: "When reading about the [1 in 50 / 20 in 1000] chance of contracting the new Disease X, I have tender, concerned feelings for the individual who might contract the disease." How well do these statements describe your experience? (1 Not at all 2 3 4 5 6 7 Extremely well)  
**Study 2:** Imagine that you are told that the population of [older / younger] adults has a [1 in 50 / 20 in 1000] chance of contracting Disease X. In your opinion, this chance is: (1 = extremely low; 7 = extremely high)  
**Study 3:** Put yourself in the position of an individual who might contract Disease X. Think about how you would feel knowing there is a [1 in 50 / 20 in 1000] chance of contracting the disease. Please write a sentence below to describe your feelings.  
**Study 4:** Example IRI item: "Before criticizing somebody, I try to imagine how I would feel if I were in their place (PT)  
**Study 5 Pre-test:** Please rate how easy or difficult it is for you to recall examples of people contracting:[list of 16 diseases] Anaplasma phagocytophilum infection/COVID-19 (0) Very difficult - (10) Very easy  
**Study 5:** Imagine you read a statistic from a trusted source stating that in a certain town, [1 in 50 / 20 in 1000] individuals currently have a diagnosis of [Coronavirus Disease 2019 (COVID-19) / Anaplasma phagocytophilum infection]. In your opinion, this probability is: Very low - (7) Very high  
**Study 6: Control Group:** Imagine you read a statistic from a trusted source stating that in a certain town, [1 in 50 / 20 in 1000] individuals currently have a diagnosis of Anaplasma phagocytophilum infection. In your opinion, this probability is (1) very low - (7) very high.  
**Study 6: Visualizing Group:** Try to imagine a [small /large] group of [50/1000] people, and visualize [1 person /20 people] in that group who has the disease. In your opinion, this probability is (1) very low - (7) very high.  
**Study 7 Abstract:** Please rate how easy or difficult it is to mentally visualize the following proportion: [1 in 50 / 20 in 1000] (1 = very difficult, 7 = very easy)  
**Study 7: Concrete:** Please rate how easy or difficult it is to mentally visualize the following proportion: [1 person in a room of 50/ 20 people in a room of 1000] (1 = very difficult, 7 = very easy)  
**Study 8:** Please rate how easy or difficult it is to mentally visualize the following proportion: [3 in 50 / 60 in 1000] (1 = very difficult, 7 = very easy)  
**Study 9:** Please rate how easily you can think of real-life examples or situations where this ratio might apply: [1 in 50 /20 in 1000]. (1 = very difficult, 7 = very easy)  
**Study 10:** Please list the first real-life example or situation that comes to mind for the following ratio: [1 in 50 / 20 in 1000].

## Results



## Conclusions

Across all studies, the **1-in-X bias** was **not moderated by**:

- higher **empathy** elicited by the 1-in-X format relative to the N-in-NX format,
- the **personal relevance** of the outcome (e.g., affecting the participant's age group),
- instructions encouraging participants to consider how they would feel about a 1-in-X chance,
- participants' **dispositional empathy**,
- the **ease of generating examples of the outcome** (outcome availability),
- instructions to imagine a concrete group and **visualize a single person** (vs. working with abstract ratios).

However, participants:

- judged 1-in-X **proportions** (but not 3-in-X) as **easier to mentally visualize** than N-in-NX.
- found it easier to **think of real-life examples** for 1-in-X than for N-in-NX,
- however, did not spend more or less time generating those examples across formats.