

Cognition and Perception

1. Why would evolution-minded cognitive psychologists think it is more likely that the mind consists of many specialized mechanisms rather than a few general-purpose mechanisms?
2. Why would we expect sex differences in cognition? In what areas?
3. What is the evidence that frequencies are a special domain of human reasoning?
4. Why might it be more adaptive to have inaccurate perception than accurate perception?

Part of your new clerical job at the local school is to make sure that student documents have been processed correctly. Your job is to ensure that the documents conform to the following alphanumeric rule:

If a person has a 'D' rating, then his/her document must be marked code '3'.

You suspect that the secretary whom you replaced did not categorize the documents correctly. The cards below have information about the documents of four students at the school, each card representing one person. One side of a card states a person's letter rating and the other side of the card states that person's number code.

Which cards do you need to turn over to see if the documents of any of these people violate this rule?



In its crackdown against drunken drivers, Massachusetts law enforcement officials are revoking liquor licenses left and right. You are a bouncer in a Boston bar, and you'll lose your job unless you enforce the following law:

If a person is drinking beer, then he/she must be over 20 years old.

The cards below have information about four people sitting at a table in your bar. Each card represents one person. One side of the card states what a person is drinking and the other side of the card tells that person's age.

Which cards do you need to turn over to see if any of these people is breaking the law?

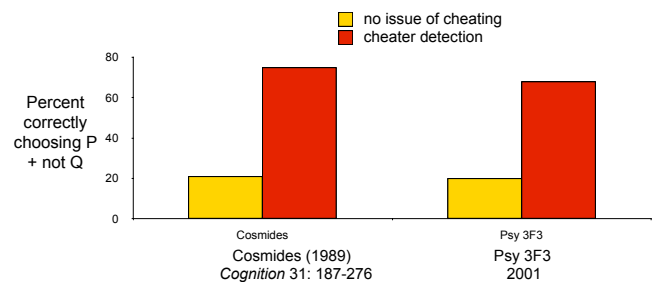


The Wason Selection Task

Number of different combinations chosen by a previous class:

Drinking problem ("cheater detection"): 7

School records (cheating not an issue): 15 (every permutation!)



Can a recent experience of being cheated make us more vigilant and better at detecting cheaters?

Cosmides reasoned that detecting cheaters who might impose substantial costs on you (or your kin and allies) would have conferred a selective advantage. A. Chang wondered if being vigilant for cheaters varies across situations.

Hypothesis: Chang hypothesized that recalling being cheated will make cheating salient and improve the % who correctly answer the cheater detection problem, while recalling being a beneficiary of someone's kindness or generosity will not.

Being cheated makes you angry. Recalling being cheated makes you feel angry. Would recalling a situation that made you angry also facilitate cheater detection? And recalling being happy wouldn't?

Will recalling incidents that made you feel cheated or made you angry help you solve this cheater detection problem?

Experimental protocol: between-groups design.

Write a 1-page story of an event in which you:

- Were particularly happy
- Were the beneficiary of someone's kindness or generosity
- Were angry
- Were the victim of someone cheating or swindling you.

Solve logic problem: cheater version.

People recalling a situation in which they were angry or were cheated solved "the cheater detection problem" more often than those who had recalled being happy or a beneficiary.



Chang & Wilson (2004) *E&HB*

Cognitive Illusions

The Conjunction Fallacy

Linda is a women's studies major with a part-time job. She feels passionately about women's rights in the workplace and hopes to go to law school someday. Which is more probable?

- a) Linda is a bank teller
- b) Linda is a bank teller and active in the feminist movement

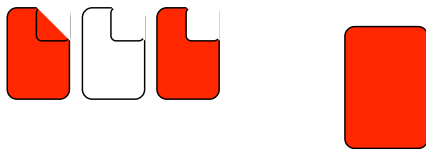
Think of 200 women like Linda. How many of them are:

- a) bank tellers?
- b) bank tellers and active in the feminist movement?

Individuation in Statistical Inference

Three cards are in a hat. One is red on both sides. One is white on both sides. One is red on one side and white on the other. A single card is drawn randomly and tossed into the air.

What is the probability that the red-red card was drawn, assuming that the drawn card lands with a red side up?



(Bar-Hillel & Falk, 1982)

Individuation in Statistical Inference

The majority of people (66-79%) answer 1/2.

Fewer than 10% give the correct answer of 2/3.

The frequency of the wrong answer points to two problems with the question:

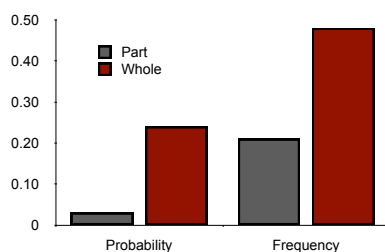
1. It was posed in a probabilistic, not frequency, format.
2. It parses whole objects into parts (sides of a card), which is not a natural format for making inferences.

Individuation in Statistical Inference

If you present the same problem, but add that the drawing is repeated 30 times, the percent of correct responses rises to 28% (Brase, Cosmides & Tooby, 1997).

On another set of problems (candy canes) the following results were found:

Both framing the problem in terms of frequency and whole objects increased the proportion of correct answers.



Probability Format

The probability that a patient has breast cancer is 1%. ← Prior probability

If a patient has breast cancer, the probability that a radiologist will correctly diagnose it is 79%. ← Sensitivity or hit rate

If a patient has a benign lesion, the probability that the radiologist will incorrectly diagnose it as cancer is 9.6% ← False positive rate

What is the probability that a patient with a positive mammography actually has breast cancer? ← Most (95%) physicians say about 75%

Frequency Format

A physician has seen 1000 people, 10 of whom have a certain disease. ← Prior probability

Of those 10, 8 showed symptoms. ← Sensitivity or hit rate

Of the 990 not afflicted, 95 showed symptoms. ← False positive rate

What is the probability that a new patient with symptoms has the disease? ←

About 50% of physicians get the right answer.

Bayes' Theorem

$$p(D|S) = \frac{p(D) * p(S|D)}{p(D) * p(S|D) + p(D') * p(S|D')}$$

$p(D|S)$ = probability of a disease given a symptom

$p(D)$ = probability of the disease in the overall population

$p(S|D)$ = probability of the symptom in people with the disease

$p(D')$ = probability that someone doesn't have the disease

$p(S|D')$ = probability of having the symptom with no disease

Gigerenzer's Method

$$P(D|S) = \frac{\text{Number with both the symptom and disease}}{\text{Total number with the symptom}}$$

$$p(D|S) = \frac{p(D) * p(S|D)}{p(D) * p(S|D) + p(D') * p(S|D')}$$

$p(D) * p(S|D)$ = number with both the symptom and disease

$p(D') * p(S|D')$ = number with the symptom but no disease

$p(D) * p(S|D) + p(D') * p(S|D')$ = total number with the symptom

Gigerenzer's argument has two parts:

1. Evolutionary (and developmental) primacy of frequency formats

"If there are mental algorithms that perform Bayesian-type inferences from data to hypotheses, these are designed for event frequencies by natural sampling"

2. Ease of computation

Arguments for Adaptation

"mental algorithms were designed for frequency formats"

Humans can monitor frequencies with fair accuracy.

Humans process frequencies almost automatically.

Evidence from counting in animals and children.

Probability learning derives from frequency learning.

Humans can monitor frequencies with fair accuracy.

People remember (relative) frequencies well (e.g. people are very accurate when asked about the relative number of restaurants in fast-food chains).

We probably don't code frequencies by overt counting. Subjects given explicit counting directions, a pencil and paper perform the same as those without on relative frequency tasks.

Coding Frequencies

There is evidence for both indirect and direct coding.

Indirect theories of frequency calculation posit that frequencies are derived from aspects of memory other than frequency (like the strength of connections in a neural network).

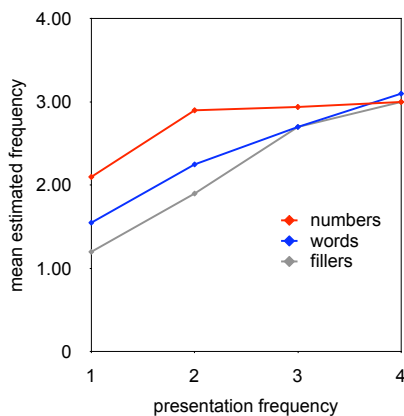
Direct theories say frequencies are represented by a special frequency-counting mechanism (compatible with Gigerenzer).

Evidence for Direct Coding

Jonides & Jones (1992) gave the following list of words in different frequencies and asked subjects to either write down the first word or the first number associated with the word. The numbers condition interfered with the subjects' recall of word frequencies more than did the words condition.

1	2	3	4
Lone	Twins	Triplicate	Quadrangle
Solo	Couple	Few	Wheels
Alone	Pair	Triplets	Quartet

Estimated vs. Actual Relative Frequency



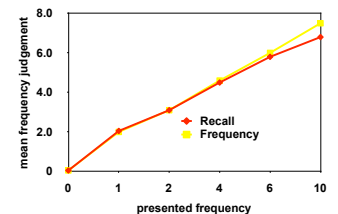
The processing of the words in the numbers condition interfered equally with frequency processing for all words. It did not increase with magnitude of the number associated with the word. Further experiments show that this interference is generated at encoding, not retrieval.

Humans process frequencies almost automatically.

Hasher & Zacks (1984) show that frequency processing is automatic by giving evidence for the following criteria:

1. People process frequencies equally well whether they are consciously intending to or not.

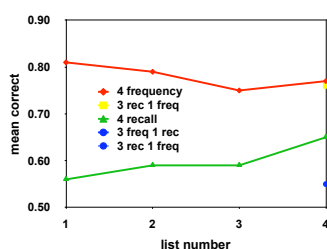
People were told that they would be given either a recall test or a frequency test before presentation of a word list. These instructions made no difference in performance.



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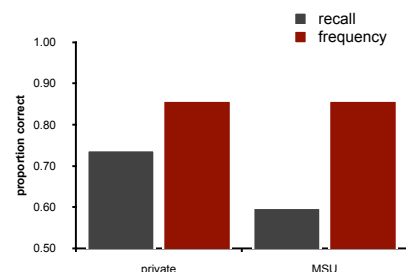
2. Training does not improve performance on frequency tests.



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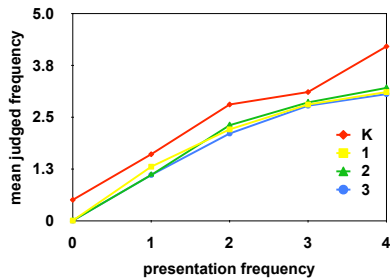
3. Education, social class and "intelligence" have little impact on frequency estimating ability.



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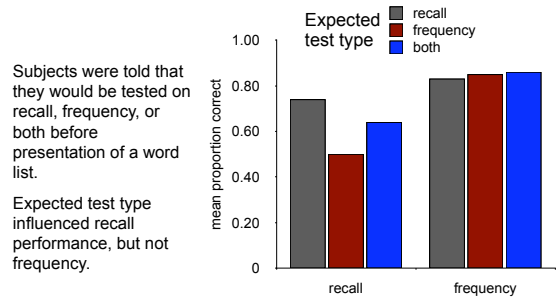
4. Frequency processing is unaffected by age after about five years.



Humans process frequencies almost automatically.

Hasher & Zacks (1984) show that frequency processing is automatic by giving evidence for the following criteria:

5. Simultaneous processing demands have no effect on frequency processing.



Subjects were told that they would be tested on recall, frequency, or both before presentation of a word list.

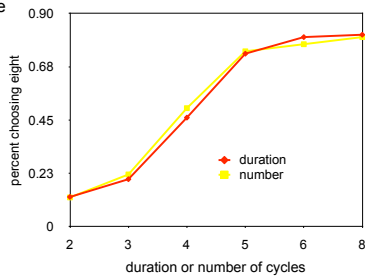
Expected test type influenced recall performance, but not frequency.

Evidence from Counting in Animals

Numerosity vs. length of signal (Meck & Church 1983)

Rats were trained to press one lever in response to a sequence of 2 tones in 2 seconds and another lever in response to 8 tones in 8 seconds.

After training, rats were given either 4 tones lasting 2-8 second or 2-8 tones lasting 4 seconds.



Critiques of an Evolved Module for Frequencies

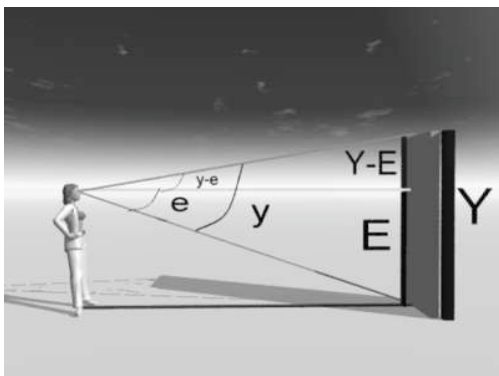
Low Accuracy Even with Frequencies

If we have a module designed to reason with frequencies, why do even physicians (supposedly highly intelligent people) only get about half the frequency formatted problems correct?

Ease of Computation

Why would we need to posit an evolved mechanism if increased ease of computation due to a frequency format is sufficient to explain improved performance? Is it sufficient?

Evolved Navigation Theory (ENT)



Competing Theories

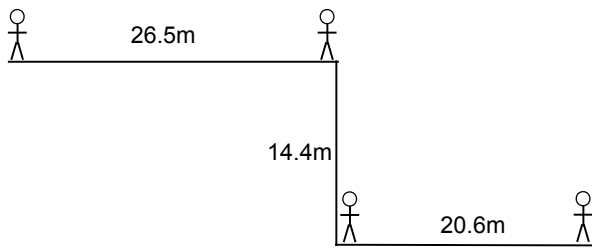


Gravity Theory

Foreshortening of receding horizontals



The Descent Illusion



Jackson & Cormack (2007) *Perception & Psychophysics*

Vocabulary

1. Wason selection task
2. Conjunction Fallacy
3. Probability
4. Frequency
5. Bayes' Theorem
6. ENT
7. Environmental vertical illusion
8. Descent illusion
9. Acrophobia