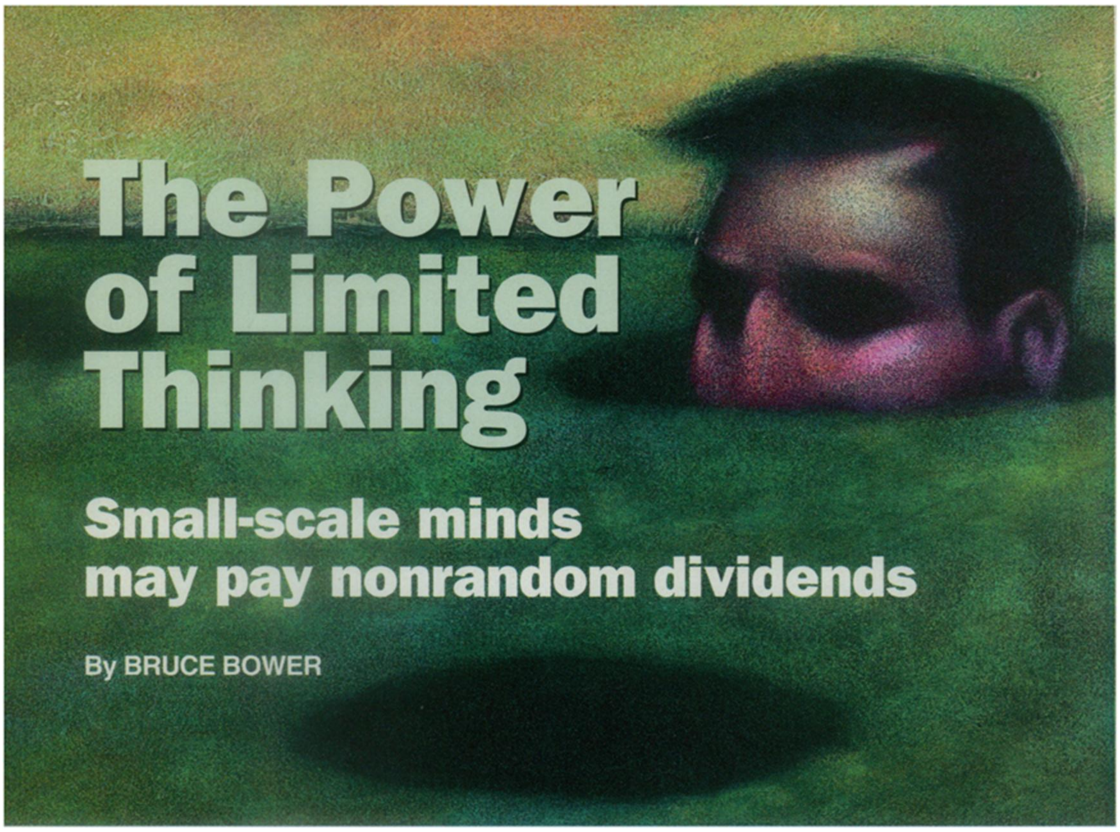

The Power of Limited Thinking

Small-scale minds may pay nonrandom dividends

By BRUCE BOWER

No wonder newborn babies cry so much. After enduring a perpetually dark, cramped maternal abode, they are abruptly evicted, naked and squirming, onto a planet notable for what 19th-century psychologist William James called its "blooming, buzzing confusion." Spitting in the face of this indignity, infants proceed to suck up predictable regularities in their strange new world as avidly as they ingest their mothers' milk or a bottle of formula.

Recognition of features that consistently go together in one's surroundings makes life much easier, not to mention less confusing. Such insights are hardly foolproof; nonetheless, infants and young children routinely come to expect that an anguished cry quickly results in an appearance by Mom, any object that moves without visible help is alive, and big people talk by stringing together certain types of sounds.

Teenagers and adults also lap up environmental correspondences. Note the following common judgments: Crops grow best after spring rains, a new acquaintance who talks with a drawl and peppers her speech with "y'all" comes from the South, and athletic apparel emblazoned with a swoosh design makes its wearers look and feel "cool." The meanings generated by putting two and two together in this fashion, as quickly as possible and with a minimum of error, depend on where you live and the range of your experience.

Ironically, this ability also thrives on a limited memory, argues psychologist Yaakov Kareev of the Hebrew University of Jerusalem. By and large, people temporarily hold and manipulate no more than eight or nine pieces of information in memory at a time. Yoked to this pint-sized working memory, even the most diligent tiller of a field of experience poops out after he or she has turned up a mere handful of apparent regularities.

Statisticians have noted for more than 40 years that when the values of two variables tend to change together, the mathematical strength of their correlation is greater in a small sample of values than in a much larger one. A meager working memory trades on this phenomenon, Kareev contends. From a "narrow window" of worldly observations, it amplifies regularities that exist in much broader contexts, he says.

In complex social and physical worlds, a paltry working memory thus offers more than enough insight into positively correlated events to compensate for the false alarms that it sometimes triggers. Young children, in particular, may make rapid developmental advances—say, learning to recognize and speak a native language—thanks to the perceptual punch of their puny working memories, according to the Israeli researcher.

"What I'm showing is that our cognitive limitations help us to detect regularities in the world, even if we pay a price by sometimes perceiving positive correlations that don't exist," Kareev holds.

For several decades, psychological research has emphasized the intuitive errors alluded to by Kareev. In a pivotal 1971 study, Daniel Kahneman of Princeton University and the late Amos Tversky of Stanford University argued that inaccurate assumptions about random sampling undermine people's ability to perceive events that genuinely go together.

Small samples of information drawn at random from a large population are mistakenly treated as similar to one another and as highly representative of the entire population, Kahneman and Tversky asserted. Even scientists fall for this illusion, they noted. For example, in one experiment, psychologists concluded that a statistically significant relationship between two variables that emerges in a study of 20 individuals will probably reappear in an additional study of 10 individuals, whereas the odds of this happening are only about 50-50.

Moreover, Kahneman and Tversky proposed, people believe that in a random sequence, extended runs of one value or another inevitably cancel each other out. In one illustration of this so-called gambler's fallacy, volunteers wrongly assume that a run of heads in a sequence of random coin flips will give way to a corrective series of tails to result in roughly equal numbers of heads and tails overall.

People also tend to assume that random sequences of two values alternate frequently from one value to another and do not contain extended runs of a single value. As a result, they regard the sequence "HHTTHTHTTH" as a better example of randomness than "HHHTHTHHHH," although the chances of observing either sequence—or any other of equal length—are the same.

Additional evidence has implicated our randomness-challenged minds in real-world errors of judgment. In an influential 1985 report, Tversky and psychologist Thomas Gilovich of Cornell University debunked the widespread belief that basketball players have a "hot hand" when they sink a slew of consecutive shots. An analysis of National Basketball Association shooting statistics, as well as observations of college basketball players, found that the frequency and duration of shooting streaks did not exceed chance fluctuations.

In other words, the researchers concluded, a player's chance of making a shot rests heavily on athletic skill but has virtually nothing to do with the results of his or her previous shots.

Along similar lines, many people mistakenly believe that their arthritis pain responds to changes in weather, reported Tversky and Donald A. Redelmeier, a physician at the University of Toronto, in the April 2, 1996 PROCEEDINGS OF THE

National Academy of Sciences. Rheumatoid arthritis patients tracked for 15 months exhibited no association between self-reports of arthritis pain and substantial changes in local barometric pressure, temperature, and humidity, the scientists found.

They attributed the widespread certainty that the weather influences arthritis pain to "selective matching, the tendency to focus on salient coincidences, thereby capitalizing on chance and neglecting contrary evidence."

Such findings raise concerns that people distill all sorts of misleading beliefs out of a heady broth of random events. Another research camp, however, suspects that an undercurrent of practical thinking flows beneath surface assumptions about randomness.

In a 1982 report, psychologist Lola L. Lopes of the University of Iowa in Iowa City noted that despite the existence of mechanical random number generators, randomness is neither clearly defined nor well understood by mathematicians and philosophers—much less participants in psychological experiments. The critical matter, she argued, concerns the uses to which people put their beliefs about what makes an array of events "random."

Over the past 5 years, Kareev has explored that issue. In an initial experiment, he found that when volunteers blindly guessed the outcome of a series of coin tosses, they came much closer to generating random sequences of responses—at least those of the sort found in random number tables—than they did when they responded to instructions to devise a random string of heads and tails.

Conscious attempts at simulating randomness stray badly because participants try to produce a sequence that reflects how often each value occurs in an entire population, but they do so at a length limited by their working memory, Kareev suggested.

People first accurately estimate the relative frequency of each value over the long haul; other experiments have shown that humans and other animals approximate the frequency of events in their environment with considerable success (SN: 1/29/94, p. 72). For instance, people infer that heads and tails will turn up in equal proportions over an extended series of coin flips.

Then, Kareev proposed, each individual constructs a sequence of perhaps seven or eight items—whatever working memory will allow—that displays each value's long-term frequency of occurring. In these brief sequences, volunteers alternate back and forth between heads and tails in order to portray the randomness they associate with a large number of coin flips.

In a follow-up study published in the July 1995 Psychological Review, Kareev reported that groups of college students tended to overestimate the extent to which positive correlations occurred in experimentally controlled samples of information. This "positive bias" improved their ability to discern actual positive relationships in the samples and interfered with their detection of negatively correlated variables, he concluded.

"Positive bias may be a rational predisposition for early detection of relationships that are potentially more useful than negative correlations," the Israeli scientist says.

One task in his study required students to pick, one at a time, 128 envelopes from a bag. For each envelope, which was colored either red or green, they guessed whether an Israeli coin it held was marked with an X or an O. For every correct guess, they got to keep the coin, which was worth about 3 cents. In some trials, a specific combination of envelope color and symbol (say, green and X) tended to occur together, thus bearing a positive relationship, or tended not to occur together, providing a negative relationship. In other trials, no such relationship existed.

Students perceived more numerous positive correlations between symbols and colors than actually existed, Kareev says. They also generated the greatest number of accurate guesses about payoff pairs of symbols and colors that occurred together most often. Judgments proved least accurate in trials that contained negatively correlated values.

Strikingly, the ability to detect positive correlations rises as working memory capacity declines and as volunteers render decisions based on progressively smaller samples, Kareev reported in the September Journal of Experimental Psychology: General.

In one experiment, using the previous task with colored envelopes containing X- or O-marked coins, Kareev and two colleagues measured the participants' working memory capacity and divided them into two groups. The lower-capacity group perceived a more extreme degree of positive correlation between various colors and symbols than actually existed. The higher-capacity group reported fewer false correlations but also selected fewer of the rewarding symbol-color combinations.

A second experiment used a set of 100 cards, each bearing a small circle with two lines emanating from it. One line was always horizontal and varied in length; the other maintained a constant length but varied in its angle from the horizontal. Throughout the 100 cards, the length of the horizontal line displayed a strong positive correlation to the angle of the other line: The size of the angle shifted predictably as the horizontal line got longer or shorter.

Each of 144 participants first took a test to determine how many consecutive numbers he or she could hold in working memory. Individuals then drew a sample of cards, the size of which was either two fewer, equal to, or two more than what their working memory could hold. After studying the cards, they were given a new card that displayed only one of the lines. They then predicted either the length of the horizontal line or the size of the angle formed by the corresponding line.

If the cards in a sample were hidden while volunteers made their predictions, the people who drew the smallest samples perceived corresponding line lengths and angles with the greatest accuracy, Kareev says. If the cards remained in view, dispensing with the need to call on working memory, the largest samples yielded the best predictions.

Small samples offer the most help in real-world situations, where people usually encounter items one at a time and make decisions without having a chance to peruse a huge body of relevant information, Kareev contends.

Kareev's findings coincide with prior evidence that decisions in uncertain circumstances profit from limited knowledge (SN: 7/13/96, p. 24). A minuscule working memory may help young children to pick up regularities in adult speech or other complex facets of the world without having to rely on brain circuits genetically tailored for each task, the Israeli psychologist notes.

A built-in amplifier of positive correlations may allow 8-month-olds, for instance, to notice with remarkable ease which speech sounds occur together frequently when adults speak (SN: 5/3/97, p. 276).

"The idea that you get hit in the face with positive correlations as a result of having a limited working memory capacity is very powerful," remarks psychologist Nora Newcombe of Temple University in Philadelphia. "It suggests that the human mind is designed to look for positive correlations without having to perceive all of the background noise in an environment."

Many questions remain unanswered, Kareev says, such as whether people with particularly weak working memories notice that they jump to false conclusions about apparent regularities fairly often and become more cautious as a result.

Further research needs to expand on Kareev's theme that human judgment makes a virtue out of mental imperfections, comments psychologist Jeffrey Elman of the University of California, San Diego in La Jolla.

"We are inference engines," Elman says. "But the question is, what does it mean to be a good thinker?" □