

We Sing the Praise of Good Displays: How Gamblers Bet in Casino Roulette

Maya Bar-Hillel and Ro'i Zultan

This paper tells a tale of serendipity, due to a felicitous figure. Our message is that a good figure can sometimes do more than display well those features of one's data that one intends to highlight, by also leading to new and unexpected insights.

For some years now, the first author has been interested in position effects in simultaneous choice, and particularly in the so-called middle bias. By simultaneous choice, we mean choice from simultaneously presented options (as in store displays) rather than sequentially presented options (as is "American Idol"). By position effects we mean influences on choice that can be attributed to its position. A case in point is middle bias, which is the greater tendency to choose items when they are placed in the middle of a spatial display, such as the documented tendency for guessers in multiple-choice tests to gravitate towards middle answers, or that of supermarket shoppers to pick the middle cans from an array of identical cans displayed on the shelf.

This paper is not about position effects per se, but we shall hint at why we find such effects interesting. First, because although middle bias is the most pervasive position effect in simultaneous choice, it is not the only position effect. In voting ballots, for example, the best place to be listed is at the beginning. In restaurant menus, both the beginning and the end are better places than the middle to place items one wants to enhance the sales of. Figuring out what causes position effect differences between tasks, as well as within tasks, is interesting in itself. Second, understanding which positions are more advantageous and which less is clearly important on a practical level for anyone who wants to influence choice—whether in simultaneous or sequential choice.

Real-world data affording an exciting opportunity for observing middle bias presented itself in a 2006 paper by James Sundali and Rachel Croson on gambling patterns in roulette. Roulette, the quintessential casino game, was apparently invented in France at the turn of the 19th century. It consists of a large wheel along the edge of which appear the numbers 1 to 36, colored red or black, as well as the green 0 and, in American roulette, also 00. When the wheel is spun, a small metal ball bounces around the edge, finally coming to rest, along with the wheel, on one of the 38 indentations,



Figure 1. An American roulette wheel

called pockets. Gamblers can bet on a single number (called straight-up bets), or on some properties shared by subsets of these numbers, such as "red" vs. "black," "odd" vs. "even," etc. (called outside bets). The payoffs are a function of the probability of a win.

In Croson and Sundali's study, video cameras recorded roulette betting in a Reno, Nevada, casino. Chips that gamblers placed on a single roulette table were recorded during six consecutive hours a day over a period of three days, for a total of 904 spins of the wheel and 21,731 bets. Sundali and Croson listed the frequency of straight-up bets on the numbers 1 to 36 in a conventional linearly ordered table. Their data offered an opportunity to see whether roulette gamblers are subject to middle bias (namely, a tendency to gamble on middle numbers more than on the smaller or larger numbers).

But when we looked at the table, no pattern jumped at us. For example, although the largest number of bets (1,079) was placed on 17, which is a middle number, the smallest number of bets (340) was placed on 15,

0	00	3	6	9	12	15	18	21	24	27	30	33	36	2 to 1
1	2	5	8	11	14	17	20	23	26	29	32	35	36	2 to 1
4	7	10	13	16	19	22	25	28	31	34	36	36	36	2 to 1
-1st 12-				-2nd 12-				-3rd 12-						
1 - 18				Even				Odd				19 - 36		

Figure 2. The layout of a betting table for American roulette

357	363	503	360	340	518	447	461	490	695	613	641
450	636	633	783	649	1079	983	746	703	878	925	627
362	375	682	484	525	643	595	576	521	827	664	597

a: counts

1.64	1.67	2.31	1.66	1.56	2.38	2.06	2.12	2.25	3.2	2.82	2.95
2.07	2.93	2.91	3.6	2.99	4.97	4.52	3.43	3.24	4.04	4.26	2.89
1.67	1.73	3.14	2.23	2.42	2.96	2.74	2.65	2.4	3.81	3.06	2.75

b: percentages

Figure 3. The number of bets placed on numbers 1–36

which is also a middle number. As for the exact middle numbers in the 1–36 range, namely 18 and 19—they received 518 and 595 bets, respectively—both actually lower than the expected number of bets ($21,731 / 36 = 604$, assuming uniformity).

But roulette tables afford another type of position besides that on the number scale—namely, spatial location on the table where the chips are in fact placed. Whereas the numbers surrounding the wheel have no spatial middle, because they are on a circle, and are not even in their natural order (see Figure 1), the numbered cells on the roulette table do have a spatial middle, as well as edges (see Figure 2). On the roulette table the numbers 1 to 36 are laid out in three rows of 12 numbers each. In that 3-by-12 matrix, if “middle” is narrowly construed, there are two “middle” cells,

holding the numbers 17 and 20; if “middle” is more broadly construed (namely, all cells which are not on the matrix’s edge, or all cells surrounded on all four sides by other cells), then there are ten cells, holding the numbers 5, 8, 11, 14, 17, 20, 23, 26, 29, and 32.

We took the numbers from Sundali and Croson’s Table 1 and imposed them on the roulette layout table. The spatial middle bias is now evident (see Figure 3a). For example, both the highest (1079) and the second highest (983) number of bets are on the two black cells in the dead middle of the central row, whereas all six of the lowest numbers, those under 400 (340, 357, 360, 362, 363, and 375), are on an edge, left of center.

And then serendipity struck. To display the spatial aspect of the betting preferences more clearly, we decided to display the data using a Microsoft Excel

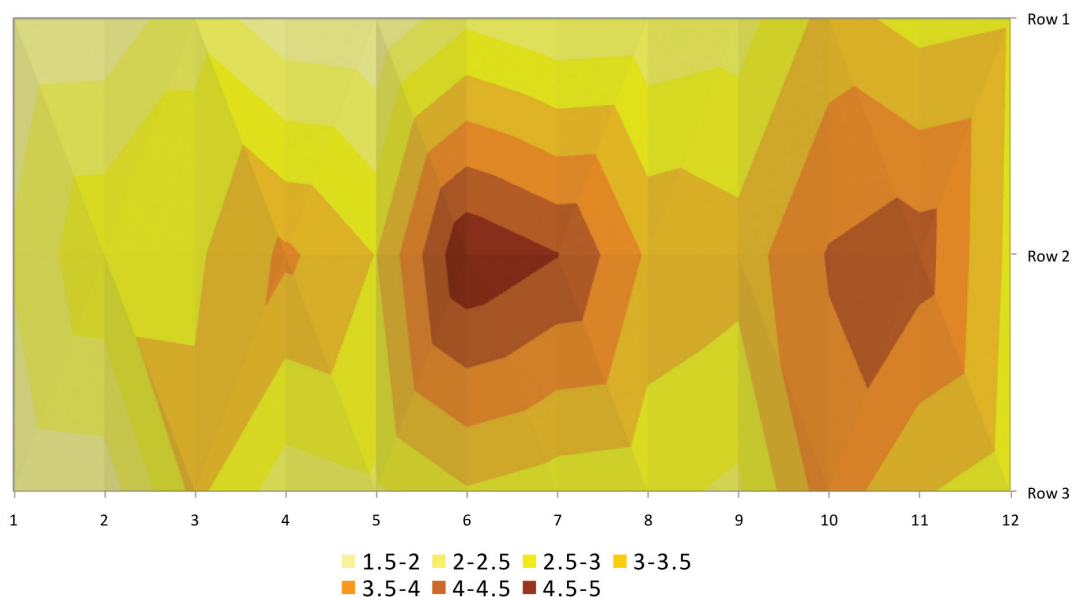


Figure 4. Contour map of percent straight-up bets placed in real roulette betting

contour surface chart. This converts discrete numerical values to continuous ones, thus suggesting trends and indicating their strength. The chart is displayed in Figure 4.

Besides showing the middle bias clearly, this figure shows three other patterns that we had neither foreseen nor expected. i. Two (or even three?) centrally located peaks rather than just one. ii. A marked left-right asymmetry. iii. A slight top-down asymmetry. What could explain these patterns?

Neither of us being a gambler, we had little knowledge of casino roulette. We ventured a conjecture, much in the manner that Sherlock Holmes famously makes his inferences: Was the left-right asymmetry perchance caused by the placement of the wheel and the croupier? A check soon confirmed that it is indeed standard in American roulette for both to be at the left side of the layout table, where the lower numbers are (the French style table with a wheel in the center of the layout table is rarely found outside of Monte Carlo). We had discovered, from a mere display of gambling frequencies, what any roulette gambler knows about the physical design of casino roulette.

So it turns out (not very surprisingly) that if gamblers are unable to stand at the left side of the roulette table, making it harder to reach, they place fewer bets there. The relative paucity of bets on the left side appears to be caused simply by its relative inaccessibility.

And why the multiple peaks? Taking the idea of accessibility a step further, we conjectured that the larger peak in the table's center, over numbers 17 and 20, is the "middle" for those gambling from the top or the bottom of the table, but the lower peak on the right end of the table, over numbers 29 and 32, seems to serve as the "middle" for the people standing on the short right end, for whom 17 and 20, let alone cells

even further to the left, are relatively hard to reach. In support of this conjecture, the figure clearly shows that the central middle, 17 and 20, is more popular than the right-side middle, 29 and 32, which is just what one might expect if there are more people standing on two wide sides than on one narrow side.

The top-bottom asymmetry is slight, but distinct: The bottom draws more bets than the top. Of the 12,282 bets placed on the top and bottom rows together, 6,878 (56%) were on the bottom row, and only 5,404 (44%) were on the top row. Since these are not necessarily independent bets, we could not perform a simple binomial test of significance on these numbers, but it is significant that for 11 columns out of the table's 12, the bottom cells contain more bets than the respective top cells ($p < .003$). If the asymmetry is not accidental, what might account for it?

Unlike the ease with which we guessed, and confirmed, where the roulette wheel is positioned, and unlike the naturalness of the assumption (which we have no direct data to confirm) that there would be fewer people standing on one narrow table side than on two wider sides, here our conjectures are pure speculation. One possibility is that there were more people on the bottom side than on the top because it is somehow more accessible for people wandering around the casino (e.g., it is closer to the hall's entrance, or to the casino's free bar). Imagine how exciting it would be if these speculations were confirmed by observation, demonstrating that, like Sherlock Holmes, we can infer facts about the casino floor without being there, just from the contour figure.

Of course, we could be wrong, and would then have to explore other, more subtle, possibilities, such as that it is not the number of people but the kind of people who prefer different sides of the table. Perhaps, for example,

The contour surface chart was constructed in the following manner:

- i. All adjacent data points—vertically, horizontally, and diagonally—were connected using straight lines. This procedure generated 22 squares $([12-1] \times [3-1])$ defined by the 12-by-3 data points.
- ii. Numerical values along each of these lines were interpolated from the two connected numbers by filling in values linearly.
- iii. In each pair of intersecting diagonals within a square, the diagonal with the lower value at the intersection point was deleted, leaving only the one with the higher value.
- iv. The numerical values along the remaining lines were converted into percents (ranging from 1.56% of the bets, placed on the number 15, to 4.97% of the bets, placed on the number 17), and then categorized into seven categories: 1.5%–2%; 2%–2.5%; 2.5%–3%; 3.5%–4%; 4%–4.5%; 4.5%–5%.
- v. Finally, same-value points equal to the 6 category boundary values (2, 2.5, 3, 3.5, 4, 4.5) were connected to form polygons (closed nonintersecting contour lines).
- vi. As in a topographic map, the areas that contain the same range of values were colored with the same color.

the bottom attracts a different kind of gambler, those who wish to make so-called outside bets (e.g., on categories such as “black-red” or “odd-even”), which is easier to do from that side (Figure 2). This different kind of gambler might simply be a heavier gambler, even on straight-up single numbers.

It does not matter that we cannot explain this feature of the figure without gathering further data. On the contrary, the point of this little article is that a good figure can bring out patterns in the data that might otherwise go unnoticed, thereby raising new hypotheses that can be empirically tested. What the casino floor

looks like is not a particularly interesting hypothesis for psychologists to check, whereas the hypothesis that gamblers who make more on outside bets also make more on straight-up bets (namely, that the correlation between these two types of gambles is not negative, but positive) is more so. But both demonstrate how the contour figure reveals, or at least suggests, new facts that it was not meant to display, and that take us beyond the data.

In our little tale about the potential of good displays, a contour figure based on data about the frequency of bets on the numbers 1–36 first confirmed the existence of a middle bias in placing bets on a roulette table; this was our impetus for drawing it in the first place, and it adds a striking example to the roster of middle bias contexts. The existence of more than one middle peak allows us, serendipitously, to add these data to the roster of accessibility effects on choice.

Accessibility effects are not exactly surprising. They are, for example, the reason manufacturers will pay to have their products displayed in salient and accessible spots on department store and supermarket floors. But most excitingly, the figure does more than add a novel example of known effects. It allowed us to infer the design of casino roulette and perhaps also of the casino floor. If our interpretations of the contour map are correct, we would expect to find different patterns in a Monte Carlo roulette design that has the wheel at the center of the layout table. In particular, it should abolish the left-right asymmetry. Of course, the simplest way of finding out how a casino floor or a roulette wheel is designed is to observe them directly. But the fact that it may be possible to “see” them by inference from a display of betting data is what we found exciting—and the reason for sharing it with *CHANCE* readers. ■

Further Reading

Bar-Hillel, M. 2011. Location, location, location: Position effects in simultaneous choice. In W. Brun, G. Keren, G. Kirkeboen, and H. Montgomery (eds.) *Acting in a social world: The role of intuitive decision processes. Essays in honor of Karl Halvor Teigen*. Oslo: Norwegian University Press. www.ratio.huji.ac.il/dp_files/dp580.pdf.

For a survey of accessibility effects in simultaneous choice, see Rozin, P., S. Scott, M. Dingley, J. K. Urbanek, H. Jiang, and M. Kaltenbach. 2011. Nudge to nobesity I: Minor changes in food displays influence food intake. *Judgment and Decision Making* 6(4):323–332. Available at <http://journal.sjdm.org/11/11213/jdm11213.pdf>.

For the original data on which this paper is based, see Sundali, J., and R. Croson. 2006. Biases in casino betting: The hot hand and the gambler’s fallacy. *Judgment and Decision Making* 1(1):1–12. Available at <http://journal.sjdm.org/jdm06001.pdf>.

About the Authors

Maya Bar-Hillel is professor of psychology at The Hebrew University. She is a member (and former director) of its Center for the Study of Rationality and is interested in the psychology of probabilistic reasoning and judgment under uncertainty, as well as in paradoxes of probability and decisionmaking. Presently, she is studying position effects in simultaneous choice and how expectation-setting labels affect product evaluation and experience.

Ro’i Zultan earned his PhD in psychology and rationality from The Hebrew University in Jerusalem. He is a research associate at University College London and will soon join the department of economics at Ben-Gurion University. His research is in decisionmaking, focusing on strategic interactions, communication, and cooperation.