Quantum theory reveals puzzling pattern in how people respond to some surveys

June 16 2014, by Jeff Grabmeier

Researchers used quantum theory – usually invoked to describe the actions of subatomic particles – to identify an unexpected and strange pattern in how people respond to survey questions.

By conventional standards, the results are surprising: The scientists found the exact same pattern in 70 nationally representative surveys from Gallup and the Pew Research center taken from 2001 to 2011, as well as in two laboratory experiments. Most of the national surveys included more than 1,000 respondents in the United States.

"Human behavior is very sensitive to context. It may be as context sensitive as the actions of some of the particles that quantum physicists study," said Zheng Wang, lead author of the study and associate professor of communication at The Ohio State University.

"By using quantum theory, we were able to predict a surprising regularity in human behavior with unusual accuracy for the social sciences in a large set of different surveys."

The study appears online in the *Proceedings of the National Academy of Sciences*. Wang conducted the study with Tyler Solloway of Ohio State, and Richard Shiffrin and Jerome Busemeyer of Indiana University.

These new findings involved an issue that has long faced researchers using survey data or any self-report data: question-order effects. Scientists have known that the order in which some questions are asked

on a survey can change how people respond. That's why survey organizations normally change the order of questions between different respondents, hoping to cancel out this effect.

"Researchers have thought of these question-order effects as some kind of unexplainable carry-over effects or noise," Wang said. "But our results suggest that some of these effects may not be mere nuisance, but actually are something more essential to human behavior."

Take, for example, one of the surveys used in the study. This was a Gallup poll that asked Americans, among other questions, whether Bill Clinton was honest and trustworthy and whether Al Gore was honest and trustworthy.

The survey changed the order in which these questions were asked between respondents and, as expected, there were question-order effects found. When respondents were asked about Clinton first, 49 percent said that both Clinton and Gore were trustworthy. But when respondents were asked about Gore first, 56 percent said that both were trustworthy.

The pattern that quantum theory predicted – and that the researchers found – was that the number of people who switch from "yes-yes" to "no-no" when the question order is reversed must be offset by the number of people who switch in the opposite direction.

Indeed, in this case, the number of people who said "no-no" – that both Clinton and Gore were not trustworthy – went from 28 percent when the Clinton question was asked first to 21 percent when Gore was asked about first.

That 7 percent decline essentially cancels out the 7 percent increase in the number of people who said "yes-yes" when the question order was reversed.

Likewise, the number of people who switched from "yes-no" to "no-yes" was offset by the number of people who switched in the opposite direction.

The researchers called this phenomenon "quantum question equality." They found it in every one of the surveys studied.

"When you think about it from our normal social science perspective, the finding is very bizarre," Wang said. "There's no reason to expect that people would always change their responses in such a systematical way, from survey to survey to create this pattern."

But from a quantum perspective, the finding makes perfect sense, Wang said. "It is exactly what we would have predicted from quantum theory. We mathematically derived this precise prediction of quantum question equality from quantum theory before we looked at any data. This had to be true if our theory is right."

It had to be true according to what is called the law of reciprocity in quantum theory, she said. Like much of quantum theory, the law of reciprocity is complex and difficult for most people to understand. But it has to do with the transition from one state of a system to another. In this case, the transition is from a state answering questions about Clinton to a new state answering questions about Gore.

Wang said that quantum question equality explains only this very specific situation in which two questions are asked back-to-back with no other information given in between.

The researchers illustrate the difference with the example of another national survey, not among the 70 studied, that asked whether disgraced former baseball players Pete Rose and "Shoeless" Joe Jackson should be admitted to the Baseball Hall of Fame. The order in which people were

asked about the two players was varied to deal with the question-order effects. But the results from this survey didn't show, as predicted by the researchers, the pattern found in the 70 surveys in the study.

That's because in between asking each question, the surveyors introduced new information by explaining to participants who these baseball players were and why there was a controversy about whether they should be admitted to the Hall of Fame.

"The simple fact that participants were given new information affects how they answer and means that quantum question equality won't hold true for cases like this," she said.

Wang said one of the most important aspects of the study was that quantum theory allowed the researchers to attain a level of exactitude rarely found when studying human behavior.

"Usually, in the social sciences we're talking about parameters: If we can predict that one factor is always larger or smaller than another, we consider that a strong finding," she said.

"But here we found a quite precise answer that is always nearly zero – the number of people who switch an answer one way are always offset by the number of people who switch in the opposite direction. That number never changed. In other words, their difference is always nearly zero. And that level of exactness is almost never found in social science research."

The larger question brought up by this study is "why?" Why must the number of people who switch from "yes-yes" to "no-no" when question order is reversed be offset by the number of people who switch in the opposite direction?

Wang said there is nothing yet proposed in standard psychological theory that would explain why this is true.

"People may reason according to different rules other than standard probability that are commonly used in social sciences. Our findings support the idea that people reason according to quantum rules instead."

More information: Paper: Context effects produced by question orders reveal quantum nature of human judgments, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1407756111

Provided by The Ohio State University