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Confidently Biased: Comparisons with Anchors Bias Estimates and Increase Confidence

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ABSTRACT

Across a wide variety of situations, exposure to anchors has been shown to bias people's estimates. What is not known, however, is whether externally provided anchors influence the confidence that people have in their estimates. Our studies had two goals. First, we tested whether exposure to anchors influenced people's subjective confidence levels (Studies 1 and 2). These studies revealed that people who made estimates after making comparisons with externally provided anchors tended to be more confident in their estimates than people who did not see anchors. The second goal was to test two explanations as to why anchors increase people's confidence. In Study 3, we tested the explanation that anchors increase confidence because participants thought the anchors provided useful information. In Study 4, we tested the explanation that exposure to anchors causes people to consider a narrower range of plausible values as compared to when not exposed to anchors. Support was found only for the explanation that comparisons with anchors increase confidence because people who are exposed to anchors consider a narrower range of plausible values. Taken together, these studies reveal the powerful influence anchors can have—they not only bias estimates, but also increase people's confidence in their biased estimates. Copyright © 2016 John Wiley & Sons, Ltd.

KEY WORDS anchoring effects; anchors; confidence; heuristics; bias

People often make numeric estimates. For example, a doctor might either explicitly or implicitly estimate the likelihood that his patient has a pulmonary embolism. Or, a professor might estimate how long it will take her to grade her students' papers. The confidence that people have in their estimates is likely to influence their later decisions and behavior. For example, should the doctor hospitalize the patient or wait to see if the patient's condition improves? Should the professor agree to attend the departmental party now or wait to see how long it takes to grade the papers? Given the importance of people's subjective confidence,[1] in their numeric estimates, it is critical that we understand the factors that can exert an influence on their confidence.[2]

A pervasive influence on people's numeric estimates is values—or anchors—encountered before people provide their estimate. A large body of research has demonstrated that estimates tend to be biased by numeric anchors (e.g., Epley & Gilovich, 2001; Mussweiler & Strack, 1999; Tversky & Kahneman, 1974). Anchoring effects—i.e., the assimilation of estimates toward previously considered values—have been observed in many different situations. For example, Chapman and Bornstein (1996) found that mock jurors tended to give larger damages awards when plaintiffs asked for more money. Anchoring effects have also been observed across a wide variety of people. For example, experts and novices both tend to exhibit anchoring effects (Englich, Mussweiler, & Strack, 2006; Northcraft & Neale, 1987). However, it does appear to be the case that more knowledgeable people are less influenced by anchors (Smith & Windschitl, 2015; Smith, Windschitl, & Bruchmann, 2013) and that people exhibit smaller anchoring effects when they gain more experience (Mussweiler & Englich, 2003).

While a large amount of research has demonstrated that anchors can bias people's estimates, it is not known whether comparisons with externally provided anchors can influence the subjective confidence that people have in their estimates. Consider, for example, the demonstration that the plaintiff's request influenced mock juror's damages awards (Chapman & Bornstein, 1996; see also Marti & Wissler, 2000). It is possible that the money requested (i.e., the anchor) not only biased the mock jurors' estimates, but also influenced their subjective feelings of confidence that they awarded the

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[1]We use the term subjective confidence in order to distinguish our studies from research on overconfidence. Studies investigating overconfidence generally have participants make judgments with objectively correct answers. For example, participants might answer 20 multiple-choice questions and then estimate the number that they correctly answered. Or, participants might be asked to estimate a quantity (e.g., the height of the Empire State Building) and provide 90% confidence intervals. In both contexts, people tend to be overconfident. Specifically, they overestimate their performance and give confidence intervals that are too narrow (for a review, see Moore & Healy, 2008). While the research on overconfidence is quite important, we focused our studies on participants' subjective feelings of confidence in their estimates. This decision was made because there are many important domains where there is no objectively correct response. For example, how much money should a plaintiff be awarded for pain and suffering, how long should a criminal be sentenced to jail, how much is seller's house worth, or how much money should I ask for when negotiating my salary? In these contexts, because there is no objectively correct response, it is not possible to evaluate whether people are more confident than they should be (i.e., there is no objectively correct level of confidence), but it is still possible to evaluate factors that increase or decrease their subjecting feelings of confidence.

[2]In this and the other studies, we decided on our target sample sizes before the studies began by considering issues related to power, monetary concerns (for the studies conducted using MTurk), and time factors. Furthermore, we have reported all conditions and measures in the description of our studies.

appropriate amount of money. We contend that exposure to externally provided anchors will not only bias people's estimates, but also *increase* their subjective feelings of confidence in their biased estimates.

There are at least two reasons why comparisons with anchors might increase people's confidence in their estimates. The first is that people might assume that the anchor provides some useful information (Jacowitz & Kahneman, 1995). For example, if a juror sees that a plaintiff is requesting $50 000 as compensation for pain and suffering, the juror might assume that the value being requested was generated after a careful consideration of other similar cases. The amount being requested, therefore, might be assumed to provide some useful information when estimating how much the plaintiff should receive.

More generally, if people assume the anchor is useful, it follows that being provided with more information (the anchor) would lead people to be more confident in their estimate than being provided with less information (not seeing the anchor). To test the idea that increases in information lead to increases in confidence, Tsai, Klayman, and Hastie (2008) had participants predict the winner of numerous college football games after being given information about the two teams. As the amount of information the participants received increased, so did their confidence that they had correctly predicted the winning team. This increase in confidence, however, was not warranted. Participants' accuracy did not increase nearly as much as their confidence (see also, Hall, Ariss, & Todorov, 2007).

The second way that anchors might increase confidence is that being exposed to an anchor could reduce the range of possible values that people consider. For example, a juror who sees that a plaintiff is requesting $50 000 might consider values in the range of $40 000–$60 000 as possible awards for the plaintiff. On the other hand, a juror who is not told how much the plaintiff is requesting might consider values from $10 000 to $100 000 as possible awards for the plaintiff. Presumably, this latter juror will be less confident in her recommended award amount because she considered such a wide range of values.

This explanation is partially derived from Mussweiler and Strack's (2000a); see also, Mussweiler and Strack (1999, 2000b) explanation of how knowledge plays a role in anchoring effects. Mussweiler and Strack explain that the estimate that people provide about a target likely represents one value that is within a range of many possible values. The value that people provide as their estimate will be the number with the highest perceived plausibility rating. Importantly, people's ranges of possible values are influenced by their background knowledge and contextual information. If, for example, they have knowledge that damages awards are generally in the $10 000–$50 000 range, they will consider values within this range. On the other hand, if they have knowledge that damages awards are generally in the $100 000–$150 000 range, they will consider values within this range. Presumably, anchors can influence people's range of possible values. That is, low anchors will cause people to have ranges lower on a given dimension and high anchors will cause people to have ranges higher on a given dimension. Most importantly, we also assume that anchors cause people's ranges to narrow, as compared to people who do not see anchors. For example, someone not exposed to an anchor might assume that damages awards could be in the $10 000–$150 000 range. Because this person is considering a much wider range of values (a signal of uncertainty), he likely would not be as confident as people who consider a more narrow range of values.

Finally, it is worth noting that it is possible that people who are biased by anchors would be *less* confident than people not exposed to anchors. Recently, De Neys, Cromheeke, and Osman (2011) had participants answer a number of base-rate problems and then indicate their confidence in their answer. When the base-rates conflicted with descriptions (e.g., 995 people in a group are 40 years old and 5 are 16 years old. Els likes techno music, loves to dance, and has a nose piercing. Is Els more likely 16 or 40?), participants tended to give estimates that were in line with the descriptions, largely ignoring the base-rates (e.g., reporting that Els is more likely to be 16 than 40). However, as compared to when base rates and descriptions did not conflict, people were less confident in their decisions than when the base-rates and descriptions conflicted. The authors suggest that the decrease in confidence occurred because people likely had some awareness that they were giving biased judgments and adjusted their confidence accordingly. With regards to the current studies, if people recognized that their estimates were biased by the anchors they might be less confident than people who gave unbiased estimates (i.e., people who did not see an anchor).

Current studies

Our studies had two primary goals. The first goal was to test whether anchors influence confidence. As described earlier, our prediction was that anchors would increase people's confidence in their estimates. Our prediction was partially based on the results of a study by Jacowitz and Kahneman (1995). In the first part of this study, students provided estimates to numerous questions and, after each estimate, indicated their confidence in their estimate. Jacowitz and Kahneman used the estimates from this calibration group to derive the anchors used for participants in the experimental group. In the second part of the study, participants in the experimental group indicated whether the target value was higher or lower than a provided anchor, estimated the target value, and then indicated their confidence in their estimate. When comparing the confidence of the calibration group to the confidence of the experimental group, the researchers found that the experimental group (i.e., those participants who saw the anchors) was more confident than the calibration group.

While this certainly supports the notion that anchors can increase confidence, it is important to point out that these two conditions were run at separate times so participants were not randomly assigned to conditions. It is possible that the difference between the calibration and experimental groups results because of selection effects (e.g., differences in dispositional levels of confidence for students who sign

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up for studies early vs. late in a given semester). Studies 1 and 2 were designed to address this concern by randomly assigning participants to either be exposed to anchors or not see any anchors. To preview our results, we found support for our prediction that anchors would increase participants' confidence in their estimates.

Finding support for our hypothesis, we next addressed our second goal: testing two explanations for how externally provided anchors might increase confidence. Study 3 tested the explanation that the anchors increased confidence because participants assumed the anchors were informative to their estimates. Study 4 tested the explanation that anchors increase confidence because they reduce the range of values that people consider to be plausible estimates of the target.

STUDY 1

In Study 1, participants were asked to imagine being a juror at a trial where the plaintiff was suing the defendant for damages. After reading the specifics of the case, the participants indicated how much money they would recommend awarding the plaintiff. Importantly, some participants were told how much the plaintiff was requesting (i.e., they were shown an anchor) while other participants were not given this information (i.e., they did not see an anchor). After providing their estimate, the participants indicated their confidence in the value they recommended. We predicted that participants who were exposed to the anchor would be more confident in their recommendation than participants who were not exposed to the anchor.

Participants and design

Three-hundred and nineteen people (34.8% female, 65.2% male; $M_{age} = 32.22$, $SD_{age} = 11.08$) from the U.S. were recruited through Amazon's Mechanical Turk. They received \$0.50 as compensation for their participation. Participants were randomly assigned to the anchor or no-anchor condition. Of those assigned to the anchor condition, half were randomly assigned to see a high anchor and half to see a low anchor.

Materials and procedure

The participants were first given a brief overview of their task; they were told they would read information about a court case and should imagine they were a juror. Next, they were presented with a scenario adapted from one previously used by Chapman and Bornstein (1996). The scenario described a case where the plaintiff was suing the defendant for pain and suffering resulting from being prescribed birth-control pills that presumably caused ovarian cancer (see Appendix A for the complete scenario). The scenario explained that the defendant had already been found guilty of knowingly prescribing unsafe pills; the question at hand was how much money the plaintiff should be awarded for her emotional and physical pain and suffering. Participants in the no-anchor condition were told that the plaintiff was asking for "a monetary award", participants in the low-anchor condition were told she was asking for \$50 000, and participants in the high-anchor condition were told she was asking for \$5 000 000. After reading the information about the case, the participants were asked how much money they would recommend the plaintiff receive for her pain and suffering. Next, the participants were asked to indicate their confidence that the amount they recommended was "…a reasonable amount of money for cases involving the plaintiff's level of pain and suffering." The participants indicated their confidence on a sliding scale with labels anchored by "Not at all confident" to "Extremely confident". Responses were scored from 0 to 100, although no numeric values were present on the response scale. Finally, the participants indicated their age and gender, and were debriefed.

Results

Confidence

Before testing our prediction that exposure to an anchor would increase confidence, we examined whether the participants' confidence varied across those who saw the high ($M = 76.41$, $SD = 22.43$) and low anchor ($M = 79.49$, $SD = 20.43$)—it did not, $t(161) = 0.92$, $p = .36$, $d = 0.14$. Therefore, we combined participants in the high and low anchor conditions. Our primary analysis concerns whether seeing an anchor influences confidence. Consistent with our prediction, participants who were exposed to an anchor ($M = 77.87$, $SD = 21.50$) were more confident in their recommendation than participants who were not exposed to an anchor ($M = 58.22$, $SD = 29.90$), $t(317) = 6.76$, $p < .001$, $d = 0.77$.

Next, we performed an ANCOVA on participants' confidence estimates while controlling for age and gender. As before, participants were more confident if they saw an anchor as compared to those who did not see an anchor, $F(1, 314) = 45.17$, $p < .001$, $\eta_p^2 = .126$. Gender was not a significant covariate, $F(1, 314) = 0.14$, $p = .71$, $\eta_p^2 = .00$, but age was a significant covariate, $F(1, 314) = 7.41$, $p = .007$, $\eta_p^2 = .023$—participants' confidence increased as age increased.

Anchoring effects

To evaluate whether participants' recommendations were biased by the anchors, we compared the recommendation estimates given by participants in the low, high, and no-anchor conditions. Estimates from five participants (1.57% of the estimates) were dropped because they were more than 3 standard deviations above the mean estimate.[3] A one-way analysis of variance (ANOVA) revealed that the anchor condition did influence participants' estimates, $F(2, 311) = 17.80$, $p < .001$, $\eta_p^2 = .103$. Follow-up contrasts revealed that participants in the high anchor condition ($M = 2\,535\,924$,

[3]In this and the other studies, including extreme values did not significantly impact the results of the analyses conducted.

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SD = 2 126 960) gave higher recommendations than participants in the no-anchor condition (M = 1 461 435, SD = 2 773 673), $t(311) = 3.43$, $p = .001$. Participants in the low-anchor condition (M = 366 494, SD = 1 193 091) gave lower estimates than participants in the no-anchor condition, $t(311) = 3.40$, $p = .001$. In short, comparisons with a high anchor caused participants to give higher estimates and comparisons with low anchors caused participants to give lower estimates than participants not exposed to an anchor.

Discussion

The results of Study 1 clearly indicate that exposure to externally provided anchors increased participants' confidence as compared to people who did not see the anchors—a finding consistent with the study conducted by Jacowitz and Kahneman (1995). Our study builds on their findings by demonstrating the effect when participants were randomly assigned to the anchor vs. no-anchor condition.

Consistent with previous research on anchoring effects, comparisons with anchors biased participants' estimates. Participants who saw a high anchor gave higher estimates than participants not exposed to an anchor; participants who saw a low anchor gave lower estimates than participants not exposed to an anchor. Taken together, the results of Study 1 demonstrate that anchors biased participants' estimates but also increased the confidence they had in their biased estimates.

STUDY 2

In Study 2, we extended the findings of Study 1 to a different domain—general knowledge questions. This was done to address a possible limitation of Study 1. Specifically, in Study 1, there was no objectively correct amount of money the plaintiff should be awarded. Therefore, it was not possible for us to say whether the increase in confidence by participants in the anchor conditions was unwarranted. In Study 2, each of the questions had an objectively correct response.

A second change in Study 2 was that the anchors were described as random and arbitrary. In Study 1, participants might have viewed the anchor value (i.e., the plaintiff's request) as useful when coming up with their award recommendation. Given that these participants had more information, perhaps an increase in confidence was warranted. To minimize the perceived usefulness or informativeness of the anchor values, the anchors in Study 2 were described as having been randomly generated and completely arbitrary.

A third change was to move from the context of a decision to a judgment. Specifically, in Study 1 the participants made a decision (i.e., their recommended award amount) while in Study 2, participants made numerous judgments (see Yates & Potworowski, 2012 for a description of judgments versus decisions). The final change was to include a measure of participants' dispositional confidence.

Method

Participants and design

One-hundred and ninety-three people (37.3% female, 62.7% male; $M_{age} = 30.76$, $SD_{age} = 9.19$) from the U.S. were recruited through Amazon's Mechanical Turk. They received $0.50 as compensation for their participation. Participants were randomly assigned to the anchor or no-anchor condition.

Materials

Participants answered six question sets (see Appendix B). Each question set contained a comparative question that introduced the anchor (e.g., "Do you think there are more or less than 350 calories in a Twinkie?"), an absolute estimate (e.g., "How many calories are in a Twinkie?"), and a confidence question (e.g., "How confident are you that your estimate is within 10% of the actual number of calories in a Twinkie?"). Participants responded to the confidence question on a 1 (not at all confident) to 7 (extremely confident) Likert-type response scale. For the participants in the anchor condition, half of the questions used high anchors and half used low anchors.

Procedure

After agreeing to participate, the participants were given initial instructions about the basics of their task. The instructions also explained that they might compare the target to a value and that this value was randomly determined and therefore "completely arbitrary." Next, the participants went through an instructions check (Oppenheimer, Meyvis, & Davidenko, 2009). [4]The participants were then informed that after they answered each question, they would indicate their confidence that their estimate was within 10% of the actual answer. They were given detailed information to ensure they understood what "within 10%" meant (see Appendix C for the exact instructions). The participants then saw each of the six question sets in a randomized order. Participants in the anchor condition saw the comparative question that included the anchor value, provided their absolute estimate, and then indicated their confidence in the accuracy of their estimate. Participants in the no-anchor condition provided an absolute estimate and then indicated their confidence in their estimate.

After answering the six question sets, the participants completed the 11 problem-solving confidence questions of the Problem-Solving Inventory (Heppner & Petersen,

[4]The instructions check involved a question asking how often the participants went to the gym in an average week with a short paragraph of instructions above the question. The instructions informed the participant to ignore the question. Furthermore, the participants were instructed that they should not look up any of the answers to the questions as we were interested in what they knew, not what they could look up. To indicate that they read the instructions, the participants were asked to type "I will not look up any information when answering the questions in this survey" into a text field. The instructions check served two purposes: 1) we could identify participants who did not read the instructions and 2) we reinforced the idea that the participants were not to look up any information about the questions they were asked.

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1982). These questions assess participants' general confidence in solving problems. Finally, participants were asked their age and gender, and debriefed.

Results

Confidence

Eight participants failed the instructions check and were dropped from the analyses (including these participants did not significantly change the overall results). We first performed an independent-samples t-test on the average of participants' six confidence estimates. As predicted, participants in the anchor condition ($M=3.38$, $SD=1.21$) were more confident in the accuracy of their estimates than participants in the no-anchor condition ($M=2.91$, $SD=0.95$), $t(183)=2.94$, $p=.004$, $d=0.44$. Next, we performed an ANCOVA on participants' average confidence estimate while controlling for their dispositional confidence (i.e., their average score on the problem-solving confidence questions), age, and gender. Most importantly, participants who saw an anchor were more confident in their estimates than participants not exposed to an anchor, $F(1, 180)=7.12$, $p=.008$, $\eta_p^2=.038$. Problem-solving confidence was a significant covariate, $F(1, 180)=3.75$, $p=.05$, $\eta_p^2=.020$—participants who reported higher levels of dispositional confidence were more confident in their estimates. Age, $F(1, 180)=1.84$, $p=.18$, $\eta_p^2=.010$, and gender, $F(1, 180)=2.27$, $p=.13$, $\eta_p^2=.012$, were not significant covariates.

An important question is whether the participants in the anchor condition *should* have been more confident than the no-anchor condition. That is, were participants in the anchor condition more likely to give estimates that were within 10% of the actual answer, therefore warranting the increase in confidence? Overall, the anchor condition did give marginally more estimates ($M=12.22\%$, $SD=12.44$) within 10% of the actual answer than participants in the no-anchor condition ($M=8.95\%$, $SD=11.86$), $t(183)=1.83$, $p=.068$, $d=0.27$. However, for two of the questions (questions 1 and 6 in Appendix B), the no-anchor condition provided a greater percentage of accurate estimates ($p=.09$ and $p=.012$), for two of the questions (questions 3 and 4) there was no significant difference between the two conditions ($p=.12$ and $p=1.00$),[5] and for the remaining two questions (questions 2 and 5), the anchor condition provided a greater percentage of accurate estimates ($p=.013$ and $p=.011$). Given the inconsistency across the questions, it seems unlikely that the increase in confidence arose because participants in the anchor condition knew they (sometimes) gave more accurate estimates. Finally, it is worth noting that an analysis restricted to those participants who did not give any estimates within 10% of the actual value still revealed that the anchor condition ($M=3.26$, $SD=1.32$) was more confident than the no-anchor condition ($M=2.71$, $SD=0.91$), $t(90)=2.37$, $p=.02$, $d=.51$. (See Study 3 for additional evidence that the increase in confidence was not because of an increase in accuracy.)

Anchoring effects

Seven estimates (<1% of the total estimates) were dropped because they were extreme or likely typos. To confirm that the anchors biased participants' estimates, we first standardized participants' estimates. Then, we computed an average of questions 1–3 (i.e., the questions that included a high anchor for participants in the anchor condition) and an average of questions 4–6 (i.e., the questions that included a low anchor for participants in the anchor condition). An independent-samples t-test on the average of questions 1–3 revealed that participants who saw a high anchor ($M=0.41$, $SD=0.57$) gave higher estimates than participants who did not see an anchor (M=−0.38, SD=0.53), $t(183)=9.68$, $p<.001$, $d=1.44$. Similarly, an independent-samples t-test examining the average of questions 4–6 revealed that participants who saw a low anchor ($M=-0.19$, $SD=0.44$) gave lower estimates than participants who did not see an anchor ($M=0.17$, $SD=0.74$), $t(183)=3.98$, $p<.001$, $d=0.82$. In short, comparisons with a high anchor caused participants to give higher estimates and comparisons with low anchors caused people to give lower estimates than those participants who did not see anchors.

Discussion

As predicted and consistent with Study 1, participants who were exposed to externally provided anchors were more confident in their estimates than participants who did not see anchors. Participants' estimates were also biased in the direction of the anchors. Taken together, this again demonstrates that participants who saw an anchor were more confident in their biased estimates.

STUDY 3

Studies 1 and 2 demonstrated that comparisons with anchors can increase participants' subjective feelings of confidence. A question that remains from Studies 1 and 2 is why anchors increase confidence. Jacowitz and Kahneman (1995) assumed that the increase in confidence occurred because participants "…evidently treated the anchor as useful information" (p. 1165). As described earlier, if people are given information they deem as useful, it is quite likely that they will be more confident in their estimates (Hall et al., 2007; Tsai et al., 2008). Study 2 provides some evidence against this explanation as the anchors were described as random and arbitrary. However, it is possible that the participants either did not pay attention to the description of the anchors or the participants did not believe that the anchors uninformative to their estimate. Therefore, Study 2 does not entirely rule out the explanation that anchors increase confidence because people view them as useful information.

In Study 3, as with the previous studies, some participants were presented with anchors while other participants did not

[5]No participants in either condition gave an estimate within 10% of the accurate answer for the question about the number of Rolling Stones studio albums that have gone platinum.

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see anchors. The important change was that the anchors were sometimes described to the participants as useful information and sometimes described as randomly generated values. If anchors increase confidence because people perceive the anchors as useful information, manipulating the perceived usefulness or informativeness of the anchors should influence participants' confidence.

Method

Participants and design

One hundred and nineteen students (79.0% female, 21.0% male; $M_{age} = 19.65$, $SD_{age} = 3.96$) from Appalachian State University participated as partial fulfillment of an undergraduate research requirement. Participants were randomly assigned to the no-anchor, random-anchor, or informative-anchor condition. Of those assigned to one of the anchor conditions, approximately half were randomly assigned to see high anchors and half were assigned to see low anchors.

Materials

Participants answered four question sets that each contained a comparative question that introduced the anchor, an absolute question, and a question that assessed confidence (see Appendix B). One change from Study 2 was that the confidence question used did not ask participants their confidence that their estimate was within 10% of the actual answer. Instead, it simply asked participants to indicate their confidence in the accuracy of their estimate—again using a 1 (not at all confident) to 7 (extremely confident) Likert-type response scale.

Procedure

After consenting to participate in the study, the participants were given instructions that differed slightly depending on their condition. All participants were told that they would be answering "general knowledge" questions and that they might not know the exact answers to the questions but should give their best guess. Participants in the informative-anchor and random-anchor conditions received additional instruction. Specifically, participants in the informative-anchor condition were told that before they make their estimate, they will see a number that, while not the correct answer to the question, might give a hint as to the actual answer. Participants in the random-anchor condition were told that, before they make their estimate, they will see a number that the computer has randomly picked and is, therefore, completely arbitrary. To further accentuate the perceived randomness of the anchors for participants in the random-anchor condition, before each question set, the participants saw text that said "For this round, the random number will be:". After the text, a series of randomly generated numbers flashed briefly before the computer selected the anchor value—apparently at random.

After reading the instructions, the participants saw the four question sets in a random order. Next, the participants completed the 11 problem-solving confidence questions (Heppner & Petersen, 1982) and demographic questions (age and gender). Finally, they were debriefed and thanked for their participation.

Results

Confidence

We first averaged participants' responses to the four confidence questions. A one-way ANOVA on participants' average confidence showed that confidence differed across the no-anchor, random-anchor, and informative-anchor conditions, $F(2, 116) = 5.21$, $p = .007$, $\eta_p^2 = .082$. Post-hoc analyses revealed that participants in the no-anchor condition ($M = 2.35$, $SD = 1.00$) were less confident than participants in the random-anchor ($M = 2.90$, $SD = 1.04$) and the informative-anchor ($M = 3.01$, $SD = 0.89$) conditions ($ps < .04$). Participants in the random-anchor and informative-anchor conditions did not significantly differ in their confidence ($p = .88$). Next, we conducted an ANCOVA on participants' average confidence while controlling for dispositional confidence, age, and gender. Importantly, this analysis revealed that the effect of the anchor condition remained significant, $F(2, 113) = 4.95$, $p = .009$, $\eta_p^2 = .080$. Problem-solving confidence, $F(1, 113) = 0.78$, $p = .38$, $\eta_p^2 = .007$, and age, $F(1, 113) = 0.90$, $p = .35$, $\eta_p^2 = .008$, were not significant covariates. Gender was a significant covariate, $F(1, 113) = 5.46$, $p = .02$, $\eta_p^2 = .046$, with males being more confident in their estimates than females.

As in Study 2, we evaluated whether more people in the anchor conditions gave estimates within 10% of the actual estimates. Overall, there were no differences between the no-anchor ($M = 33.75\%$, $SD = 12.08$), random anchor ($M = 35.53\%$, $SD = 16.06$), and informative anchor ($M = 37.80\%$, $SD = 16.88$) conditions, $F(2, 116) = 0.73$, $p = .48$, $\eta_p^2 = .012$. When focusing on each question separately, there were no differences between the conditions for three of the four questions ($p = .92$, $p = 1.00$, and $p = .82$, for questions 1, 2, and 4 respectively). For question 3, more participants in the informative anchor condition gave accurate estimates than participants in the other two conditions ($p = .023$). An analysis restricted to those participants who only gave one estimate within 10% of the actual answer (all participants estimated the start of the U.S. Civil War within 10%–161 years—of the actual start year so we could not use the same criteria as in Study 2) revealed that participants in the random-anchor ($M = 3.11$, $SD = 0.99$) and informative-anchor ($M = 3.02$, $SD = 0.78$) conditions were more confident than participants in the no-anchor condition ($M = 1.99$, $SD = 0.79$), $F(2, 72) = 13.25$, $p < .001$, $\eta_p^2 = .269$.

To investigate whether the informativeness of the anchor influenced confidence, the next analysis included only those participants who were in one of the anchor conditions. We conducted a 2 (anchor informativeness: random or informative) × 2 (anchor value: high or low) between-subjects ANOVA on participants average confidence. This analysis found no significant effects (see Figure 1). Specifically, there was no effect of anchor informativeness, $F(1, 75) = 0.17$, $p = .67$, $\eta_p^2 = .002$, no effect of anchor value, $F(1, 75) = 0.21$,

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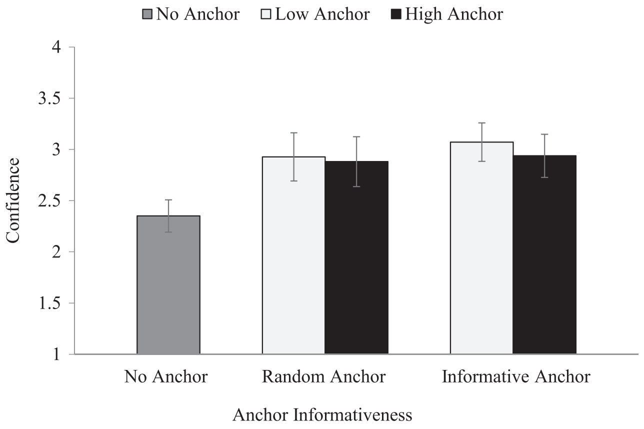

Figure 1. Participants' average confidence in Study 3 as a function of anchor value and anchor informativeness. Error bars represent ±1 standard error

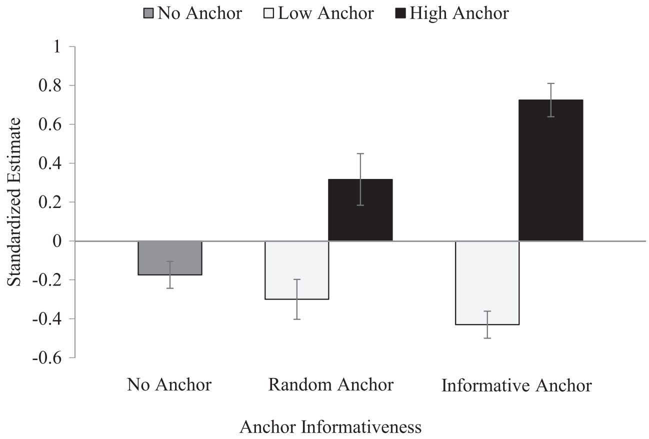

Figure 2. Participants' average standardized estimate in Study 3 as a function of anchor value and anchor informativeness. Error bars represent ±1 standard error

$p = .65$, $\eta^2_p = .003$, and no interaction, $F(1, 75) = 0.04$, $p = .84$, $\eta^2_p = .001$.

Overall, the above analyses reveal that, relative to people who did not see an anchor, participants who saw an anchor were more confident in their estimate. However, the type of anchor (informative vs. random, high vs. low) did not affect confidence levels.

Anchoring effects

To investigate whether the anchors influenced participants' estimates, we first standardized participants' responses to the four absolute estimates, and then averaged together the four standardized values. A one-way ANOVA examining participants' average standardized value across the low anchor, high anchor, and no anchor conditions revealed a significant effect of anchor condition, $F(2, 116) = 41.35$, $p < .001$, $\eta^2_p = .416$. Post-hoc analyses revealed that participants in the high anchor condition ($M = 0.52$, $SD = 0.55$) gave higher estimates than participants in the no anchor ($M = -0.17$, $SD = 0.44$) and low anchor ($M = -0.37$, $SD = 0.37$) conditions (ps $< .001$). Although in the predicted direction, participants' estimates in the low and no anchor conditions did not significantly differ from one another ($p = .14$).

To investigate the influence of the informativeness of the anchor on participants' estimates, we focused the next analysis on participants in the anchor conditions. We conducted a 2 (anchor informativeness: random or informative) X 2 (anchor value: high or low) between-subjects ANOVA on participants' average standardized estimates. This analysis revealed the expected anchoring effect; participants in the high anchor condition gave higher estimates than participants in the low anchor condition, $F(1, 75) = 74.47$, $p < .001$, $\eta^2_p = .50$. There was no main effect of anchor informativeness, $F(1, 75) = 1.69$, $p = .20$, $\eta^2_p = .022$. Importantly, there was a significant interaction, $F(1, 75) = 7.01$, $p = .01$, $\eta^2_p = .085$ (see Figure 2). Participants in the informative anchor condition exhibited larger anchoring effects (i.e., a larger difference between high and low anchor estimates) than participants in the random anchor condition. In short, the anchors influenced participants' estimates, and the perceived informativeness of the anchors influenced the magnitude of the anchoring effect.

Discussion

Study 3 once again demonstrated that participants who were exposed to externally provided anchors were more confident in their estimates than participants not exposed to anchors. It seems unlikely that the increase in confidence is caused by the anchors being perceived as informative because participants' confidence did not differ across the random-anchor and informative-anchor conditions. Because this conclusion is based on a null effect (i.e., no significant difference in confidence between the two anchor conditions), there are alternative explanations. Perhaps participants did not pay attention to the information we provided about the anchors so we did not successfully manipulate the perceived informativeness of the anchors. Or, perhaps participants in the random-anchor condition perceived the anchors to be just as useful as participants in the informative-anchor condition. Examining participants' estimates provides evidence against both of these explanations. Specifically, the informativeness of the anchor moderated the magnitude of the anchoring effects. When the anchor was described as random, participants exhibited smaller anchoring effects than when it was described as informative. Clearly, the participants paid attention to the information about the anchors and it would appear that participants in the informative anchor condition used the anchors more when making their estimates than did participants in the random-anchor condition. However, the informativeness of the anchor did not influence participants' levels of confidence.

STUDY 4

Study 3 ruled out the explanation that anchors increase confidence because they are perceived as informative. Study 4 was designed to test the explanation that anchors increase confidence because exposure to an anchor reduces the range of values that people consider as plausible estimates of the

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target value. Presumably, considering a wide range of values would lead to less confidence than considering a more narrow range of values.

Method

Participants and design

Eighty-nine students (79.8% female, 20.2% male; M_{age} = 19.60, SD_{age} = 2.84) from Appalachian State University participated as partial fulfillment of undergraduate research requirements. Participants were randomly assigned to the no-anchor or anchor condition. Of those assigned to the anchor condition, approximately half were randomly assigned to see high anchors and half were assigned to see low anchors.

Materials

Participants answered four question sets that each contained a comparative question that introduced the anchor, a question that assessed the lowest plausible response, and a question that assessed the highest plausible response (see Appendix B).

Procedure

After consenting to participate, the participants were given instructions regarding their task. Specifically, they were told that they would be asked a number of general knowledge questions, they likely would not know the exact answers to each question, but that they might have a sense as to the range of possible values. They were told that their task was to indicate their range of possible values for each question and were given an example to ensure they understand their task (see Appendix D for the exact instructions). After reading their instructions, participants in the anchor condition were asked to compare the target value with an anchor (e.g., "Do you think the top speed of a 2013 Porsche Boxter S is faster or slower than 110 miles per hour?"). Next, they indicated what they considered to be the lowest plausible value of the target (e.g., "What is the lowest plausible value for the top speed of a 2013 Porsche Boxter S?"). Finally, they indicated what they considered to be the highest plausible value of the target (e.g., "What is the highest plausible value for the top speed of a 2013 Porsche Boxter S?"). Participants in the no-anchor condition only responded to the lowest and highest plausible value questions. The four question sets were presented in a random order. After answering the four question sets the participants were asked their age and gender, debriefed, and dismissed.

Results

Range of plausible values

A small number of responses (12/712 or 1.69%) were dropped because they were imprecise (e.g., "about 150–160") or were likely typos. For each question, we computed the difference between participants' judgment about what they considered to be the highest plausible value and the lowest plausible value. Therefore, a high score indicated that participants considered a wider range of values and a low score indicated that participants considered a narrow range of values. We then standardized these difference scores and averaged together the difference scores for each question. An independent-samples t-test revealed that the average range was larger for those participants who did not see an anchor (M = 0.17, SD = 0.70) than for those who saw an anchor (M = −0.18, SD = 0.46), $t(87) = 2.84$, $p = .006$, $d = 0.61$. In other words, participants who saw an anchor considered a narrower range of values to be plausible responses than participants who did not see an anchor value.

Anchoring effects

For each question, we computed the average of participants' judgment about what they considered to be the highest plausible value and the lowest plausible value. This average value served as a proxy for participants' estimate of the target value. We then standardized these average values and calculated the mean of the averages for each question. A one-way ANOVA revealed that participants' anchor condition (no anchor, low anchor, or high anchor) affected the estimates they gave, $F(2, 86) = 14.18$, $p < .001$, $\eta_p^2 = .248$. Post-hoc analyses revealed that participants in the high anchor condition (M = 0.46, SD = 0.38) gave higher estimates than participants in the no-anchor (M = −0.09, SD = 0.61) and low anchor (M = −0.31, SD = 0.40) conditions (both ps < .001). Although in the predicted direction, estimates from participants in the no-anchor and low anchor condition did not significantly differ from one another ($p = .21$).

Discussion

The results of Study 4 reveal that comparisons with anchors affected the participants in two ways. First, the anchors influenced the location of participants' range of plausible values. Participants in the high anchor considered higher values than participants in the no and low anchor conditions. Second, comparisons with anchors decreased the range of values the participants considered to be plausible. Taken together with the previous studies, this suggests that comparisons with anchors increase confidence by decreasing the range of values that participants consider to be plausible estimates of the target.

GENERAL DISCUSSION

The studies described above had two goals—identify whether externally provided anchors can influence subjective levels of confidence and test explanations for this finding. Studies 1 and 2 established that comparisons with anchors increase the subjective levels of confidence that people have in their estimates. This is particularly troubling considering that comparisons with anchors also biased participants estimates. The increase in confidence was observed when providing estimates with no objectively correct response (Study 1) as well as when providing estimates with objectively correct responses (Study 2). The effects were observed when controlling for other variables that can impact confidence

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(i.e., dispositional problem solving confidence, age, and gender). The finding that anchors increased confidence would not be problematic if anchors also increased accuracy. However, participants who saw anchors generally gave estimates that were no more accurate than participants who did not see anchors.

Studies 3 and 4 tested two explanations for why comparisons with anchors increased participants' confidence. Study 3 found that, contrary to the prediction based on the explanation provided by Jacowitz and Kahneman (1995), anchors increased confidence regardless of whether the anchors were described as informative or not. The informativeness manipulation did, however, influence the magnitude of the anchoring effect. Study 4 found that comparisons with anchors decreased the range of values participants considered when providing their estimates. This finding provides support for the explanation that anchors increase confidence by narrowing the range of values people consider while forming their impression of the target. Presumably, participants who consider a wider range of values—a sign of uncertainty—will be less confident than participants who consider a narrower range of values.

In the studies described above, we found that externally provided anchors biased people's estimates, but also increased the confidence they had in these estimates. This finding is partially inconsistent with research by De Neys et al. (2011) who found that—in a different context—when participants were biased, they were less confident in their estimates. As mentioned earlier, De Neys et al. (2011) explained this decrease in confidence by suggesting that participants were aware their estimates were biased and adjusted their confidence to reflect this knowledge. Anchoring effects, however, appear to at least partially operate outside of people's awareness. For example, a number of studies have demonstrated that forewarning participants about the biasing influence of anchors does not reduce anchoring effects from externally provided anchors (e.g., see Epley & Gilovich, 2005; Wilson, Houston, Etling, & Brekke, 1996). If people do not realize their estimates are biased by the anchors, they will not adjust their confidence.

Subjective vs. objective measures of confidence

In the current studies, participants indicated their subjective levels of confidence in their estimates. One limitation of this approach is that we cannot assess whether participants were over- or underconfident. Our studies demonstrate that anchors increase confidence while not systematically increasing accuracy. However, it is possible that participants in the no-anchor conditions were less confident than they should be. Therefore, providing participants with an anchor might increase their confidence to a more appropriate level. One way to address this concern would be to present participants with an anchor or not and then assess confidence in a way that can be objectively evaluated. Block and Harper (1991) did just that.[6] Specifically, in three of their studies (Studies 3, 4, and 6), they had participants estimate a quantity (e.g., the height—in inches—of a standard soft-drink can) and then provide confidence ranges. Importantly, some participants were given an estimate from another participant (an anchor) before providing their estimate and giving the confidence range. Across all three studies, participants in the anchor condition were no more likely to give confidence ranges that included the true value as compared to participants in the no anchor condition—that is, they were no more accurate. However, in two of the three studies, participants in the anchor condition gave more narrow confidence ranges than no-anchor participants—suggesting they were more confident. It is important to note that, combining across the three studies, confidence ranges were not significantly narrower for participants in the anchor condition.

While not entirely consistent with our studies, the research by Block and Harper (1991) suggests that anchors might influence overprecision—one objective measure of overconfidence. There are a number of reasons why their studies found results that were not fully consistent with our research (e.g., describing the anchors as having come from another participant). Perhaps the most important difference is that we focused on subjective measures of confidence while Block and Harper examined an objective measure of confidence. Therefore, future research is needed to explicitly compare these distinct types of confidence measures. In addition to examining objective measures of confidence, future research could also examine other factors that might moderate the relationship between anchors and confidence. In the two studies conducted by Block and Harper (1991) that showed a difference between the anchor and no-anchor conditions, participants gave 50% confidence intervals, while in the study that showed no difference, participants gave 90% confidence intervals. Perhaps one reason for the different results across the studies was the different confidence intervals. (e.g., 50% vs. 90% confidence intervals).

Understanding the differences between subjective and objective measures of confidence is certainly important. However, there are many contexts where there are no objectively correct judgments. Therefore, focusing on subjective measures of confidence is also a potentially fruitful avenue for future research. In the next section, we describe a number of these domains and speculate how comparisons with anchors might influence people's judgments and decisions.

Practical implications and future directions

Anchoring effects have been observed in a wide variety of situations. As mentioned earlier—and as demonstrated in Study 1—anchors can influence mock jurors' damages awards (Chapman & Bornstein, 1996; Marti & Wissler, 2000). The finding that anchors not only bias judgments but also increase confidence could be a concern because jurors who are more confident in their recommendation might be less willing to entertain alternative recommendations. Once a juror makes a recommendation that he or she is relatively confident in, he or she might be hesitant to revise the recommendation. This seems particularly problematic if

[6]We would like to thank an anonymous reviewer for alerting us to this research.

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the juror comes up with an award recommendation before all the information in a case has been evaluated or before the juror has had an opportunity to discuss his or her recommendation with the other jurors.

Numerous studies have demonstrated that in negotiations, first offers can act as anchors (e.g., Galinsky & Mussweiler, 2001; Galinsky, Ku, & Mussweiler, 2009; Loschelder, Stuppi, & Trötschel, 2014). Specifically, the outcomes of the negotiations are often biased in the direction of the first offers. Interestingly, the current studies suggest that, while the anchors bias the outcomes, they might also increase the negotiators' confidence that they are ending with a good deal. This could partially account for why the first offers can be so powerful. If, for example, a seller of a product provides the first offer, the buyer's counteroffer will likely be biased by this first offer. At the same time, the first offer might increase the buyer's confidence that his or her counteroffer is a reasonable offer. This seems likely to increase the likelihood that the buyer would accept a final offer that is close to the initial offer. Future research could investigate whether a first offer can not only bias counteroffers, but also increase people's confidence in their biased counteroffer.

Another context that anchoring effects have been observed is with doctors' estimates of the likelihood of a particular diagnosis (Brewer, Chapman, Schwartz, & Bergus, 2007). In one study, physicians were asked to estimate the likelihood that a hypothetical patient had a pulmonary embolism after seeing a high or low anchor. Physicians who saw a low anchor gave estimates that were much lower than physicians who saw a high anchor. Interestingly, Brewer et al. found that the anchors did not influence the physicians' treatment options. The current studies suggest that, while the treatment options did not vary, the anchors likely increased the confidence that the physicians had in their estimates of the likelihood that the patient had a pulmonary embolism. It seems likely that physicians who are more confident in their estimate would also be more confident in their treatment recommendation. Therefore, it is possible that these physicians would be less likely to question their diagnosis and less likely to entertain alternative treatments. This line of reasoning is, of course, speculation at this point. Future studies could investigate whether providing anchors—relative to not providing anchors—not only increase physicians' confidence in their estimates, but also confidence in their recommended treatment. Furthermore, future research could examine whether this increase in confidence is associated with a reluctance to entertain alternative diagnoses or alternative treatments.

Finally, it is worth noting that the current studies examined how externally provided anchors influence confidence. A number of studies have examined differences between self-generated and externally provided anchors (e.g., Epley & Gilovich, 2001, 2005; Simmons, LeBoeuf, & Nelson, 2010). Although it is unclear whether anchoring effects from these two types of anchors are produced by different mechanisms (Epley & Gilovich, 2001) or not (Simmons et al., 2010), it is possible that these two different anchor types differentially influence confidence. A number of studies have examined how making an estimate before generating confidence intervals influences the size of the intervals (Juslin, Wennerholm, & Olsson, 1999; Selvidge, 1980; Soll & Klayman, 2004). In these studies, making an estimate—which could be viewed as a self-generated anchor—generally increased the size of confidence intervals. That is, people appear to be less confident when they make an initial estimate as compared to when they do not. Although there are a number of differences between these studies and the studies described in the current manuscript, it is possible that self-generate anchors might decrease confidence while externally provided anchors increase confidence. Therefore, an avenue for future research would be to compare the influence of these two types of anchors on people's confidence in their estimates.

Conclusion

Anchors can have a powerful influence on people's numeric estimates. It has long been known that numeric anchors can bias people's estimates (e.g., Tversky & Kahneman, 1974). The current studies demonstrate that anchors can also increase people's subjective levels of confidence in their estimates. This, of course, compounds the effect of the anchors because the factor that is increasing people's confidence is also causing their estimate to be biased. Furthermore, the biasing influence of anchors was observed with anchors that were informative as well as those that were clearly uninformative. While future research is needed to investigate the practical implications of the current findings, it is now clear that comparisons with anchors lead people to be confidently biased.

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APPENDIX A: TRIAL INFORMATION

The Plaintiff: Kathy, a 32-year-old housewife, was diagnosed with ovarian cancer. Since it was detected late, doctors had to remove both ovaries. The operation involved major surgery that required a week-long stay in the hospital. Because both ovaries were removed, Kathy is consequently unable to have children. Although they did not yet have any, she and her husband were planning on having children.

Late detection also means that Kathy's prognosis is poor. The cancer has spread since the surgery, which was two years ago. Kathy is almost constantly in pain, and her life expectancy has certainly been reduced. Because of her poor health, Kathy has been too weak to spend much time with friends or family members, and she has been unable to enjoy most of her favorite activities, such as biking, writing poetry, and traveling.

The Defendant: Kathy is suing her health care provider, the Greater Community Health Maintenance Organization

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(HMO), who prescribed her birth control pills, claiming that they knowingly prescribed her unsafe birth control pills. Although several brands of birth control pills are available, Kathy's HMO has a policy of prescribing this particular brand because of its low cost. Kathy had been prescribed this particular brand of pills for approximately 5 years.

Evidence Presented At The Trial: An expert witness for the plaintiff testified that there is considerable variability among different birth control pills. Although the federal government sets guidelines, it leaves drug companies some leeway in designing their own product. Before the plaintiff had been prescribed the birth control pills, the expert witness conducted a study where she gave female laboratory rats doses of the contents of the pills that the plaintiff was prescribed for a period of one year. She then evaluated their health on a variety of measures and compared to lab rats who did not receive the pills. Rats that took the birth control pill used by the plaintiff developed five times more health complications than the rats who did not receive the pills. The expert witness concluded that the pills could lead to similar health problems, including ovarian cancer, in humans. Furthermore, the expert pointed out that the vast majority of doctors stopped prescribing this type of pill once the results of her study were made public. The defendant, however, continued to prescribe the pills.

The defendant argued that, because the study was conducted on rats and not on humans, there was no evidence that the pills would increase the risk of cancer for the plaintiff.

Trial Results: The defendant (Greater Community HMO) was found to be guilty of knowingly prescribing unsafe pills to the plaintiff (Kathy).

Current Issue: Because the defendant was found guilty, they are liable for damages. The plaintiff is asking for [a monetary award; $50 000; $5 000 000] to compensate for her pain, suffering, and emotional distress. Her medical bills were completely covered by insurance, and because she did not have a job, she did not lose any income. So, in this case, compensatory damages are only to compensate the plaintiff for pain and suffering.

APPENDIX B: ALL QUESTIONS AND ANCHORS USED IN ALL STUDIES, ALONG WITH THE AVERAGE (AND SD) ESTIMATES.

Study 1

Question	Low anchor	High anchor	Low anchor estimate	No anchor estimate	High anchor estimate
If you were a juror, how much money would you recommend the plaintiff receive for her pain and suffering?	50 000	5 000 000	366 494 (1 193 091)	1 461 435 (2 773 673)	2 535 924 (2 126 960)

Study 2

#	Question	Correct answer	Low anchor	High anchor	Low anchor estimate	No anchor estimate	High anchor estimate
1	How many calories are in a Twinkie?	135	—	350	—	230.11 (100.24)	337.56 (117.84)
2	How many Grammy awards has Beyoncé won?	17	—	26	—	5.58 (3.43)	13.18 (7.14)
3	How many horsepower does a 2014 Ford Mustang GT have?	420	—	500	—	407.68 (389.29)	510.83 (190.52)
4	How many Rolling Stones studio albums have gone platinum?	29	5	—	7.90 (3.74)	8.06 (4.05)	—
5	How many countries are in South America	13	6	—	13.02 (5.79)	19.02 (11.12)	—
6	What is the population of Greensboro, North Carolina?	249 300	45 000	—	137 702 (173 679)	257 324 (370 302)	—

Study 3

#	Question	Correct answer	Low anchor	High anchor	Low anchor estimate	No anchor estimate	High anchor estimate
1	What is the top speed of a 2012 Porsche Boxter S?	172	110	210	159.32 (30.72)	188.78 (44.78)	212.20 (43.23)
2	In what year did the U.S. Civil War start?	1861	1810	1920	1843.00 (45.80)	1861.45 (58.23)	1879.29 (53.57)
3	How many countries are in Africa?	58	25	70	38.84 (19.75)	32.50 (24.49)	55.80 (30.38)
4	How many studio albums has the band U2 released?	12	7	27	7.74 (4.06)	8.05 (7.94)	18.46 (9.93)

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Study 4

#	Question	Low anchor	High anchor	Low anchor		No anchor		High anchor	
				Lowest plausible	Highest plausible	Lowest plausible	Highest plausible	Lowest plausible	Highest plausible
1	What is the lowest [highest] plausible value for the	110	210	116.96	165.87	127.12	196.51	166.96	231.96
	top speed of a 2013 Porsche Boxter S?			(27.87)	(36.48)	(58.95)	(52.90)	(52.87)	(56.98)
2	What is the lowest [highest] plausible value for the	1810	1920	1820.64	1859.86	1813.51	1866.26	1848.09	1885.30
	year the U.S. Civil War started?			(46.15)	(43.49)	(65.10)	(61.36)	(58.66)	(51.61)
3	What is the lowest [highest] plausible value for the	25	70	28.87	50.43	28.93	68.74	36.17	57.09
	number of countries in Africa?			(16.08)	(35.00)	(45.77)	(71.48)	(19.65)	(22.05)
4	What is the lowest [highest] plausible value for the	7	27	6.00	10.83	4.64	16.38	11.22	20.74
	number of studio albums released by the band U2?			(2.09)	(4.24)	(3.67)	(11.70)	(7.77)	(10.41)

APPENDIX C: INSTRUCTIONS GIVEN TO PARTICIPANTS IN STUDY 2 REGARDING PROVIDING AN ESTIMATE WITHIN 10% OF THE ACTUAL ANSWER.

"After you give your estimates, you will be asked to indicate your confidence that your estimate is within 10% of the actual answer. For example, imagine that you gave an estimate of 120 for some value, and the actual value was 100. In this situation, 'within 10% of the actual value' would be in the range of 90–110, so your answer did not fall within 10% of the actual value. On the other hand, if you gave an estimate of 95, this answer does fall within 10% of the actual answer. It does not matter if your estimate is above or below the actual value, just that it is within the 10% range."

APPENDIX D: INSTRUCTIONS GIVEN TO PARTICIPANTS IN STUDY 4 REGARDING ESTIMATES OF THE HIGHEST AND LOWEST PLAUSIBLE VALUES.

"For example, you might not know the exact population of Greensboro, NC. However, you might think that the population is sure to be more than 100 000 people. That is, you think the lowest plausible value is 100 000. You might also think that the population is sure to be less than 600 000 people. That is, you think the highest plausible value is 600 000. Therefore, even though you don't know the exact population of Greensboro, if your range of values is from 100 000 to 600 000 people, you assume that the exact value falls somewhere in this range."

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