The Impact of Implausible Anchors

Thesis

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Abstract

People’s numeric estimates are often influenced by irrelevant values, known as anchors. Traditional theories of anchoring suggest that these anchoring effects will asymptote given sufficiently extreme anchors that fall outside a boundary of plausible values. However, the existing literature provides mixed evidence for an occurrence of asymptoting. Study 1 provides a rigorous test of asymptoting of anchoring by varying the level of extremity of the anchor past a boundary of plausible values. The results of Study 1 demonstrate that anchoring can continue without asymptoting past a boundary of plausible values for the target judgment. Study 2 examines the possibility of the influence of an anchor on these boundaries of plausible values, and shows that the extremity of an anchor impacts the extremity of the nearest boundary value for both target- and domain-ranges. In addition, these shifts in the boundaries impact people’s judgments.
Dedication

Dedicated to Amos Tversky and Daniel Kahneman.
Acknowledgments

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Chapter 1: Introduction to Anchoring

Judgments and estimations may be influenced in a vast number of ways, including the presence of numeric information in one’s environment (e.g., Tversky & Kahneman, 1974). The disproportionate influence of some numerical value on judgments of decision makers is known as anchoring (Tversky & Kahneman, 1974). Anchoring, as a judgmental bias, is exceptionally robust. An anchor may be completely irrelevant information, such as social security numbers or phone numbers, or even random information, such as a number on a wheel of fortune spin, and still may influence judgments (Ariely, Loewenstein, & Prelec, 2003; Russo & Schoemaker, 1989; Tversky & Kahneman, 1974).

Indeed, anchoring has been found to be influential in a number of important domains, such as judgments of fact (Tversky & Kahneman, 1974), values of products and gambles (Tversky & Kahneman, 1974), court settlements and sentences by legal experts (Englich, Mussweiler, & Strack, 2006), quantity of purchases (Wansink, Kent, & Hoch, 1998), negotiation resolutions (Galinsky & Mussweiler, 2001) and perceptions of monetary value (Carlson, 1990; Green, Jacowitz, Kahneman, & McFadden, 1998; Simonson & Drolet, 2004).

Mechanisms of Anchoring

*Anchoring and Adjustment*
Anchoring was initially conceived of as working through a process of insufficient adjustment (e.g., Tversky & Kahneman, 1974). The “anchor and adjust” process functions with individuals first considering the anchor value, and then adjusting their judgment away from that anchor value toward some more plausible answer (Jacowitz & Kahneman, 1995; Quattrone, Lawrence, Finkel, & Andrus, 1984; Tversky & Kahneman, 1974). However, the first plausible judgment tends to still be biased in the direction of the anchor, and people tend to insufficiently correct for the influence of their anchored starting point (Epley & Gilovich, 2006).

Initial evidence for the anchor and adjust heuristic came from Tversky and Kahneman (1974). The authors had participants spin a wheel of fortune, which was rigged to land on 10 or 65. Then the participants then indicated if the real value of the percentage of African countries in the United Nations was higher or lower than the quantity on the wheel, and a judgment of what they believed the real value to be. The median value of responses for groups receiving 10 and 65 were 25 and 45 respectively, indicating that the participants insufficiently adjusted away from the wheel of fortune number. This anchor and adjustment heuristic has featured as a central component of a number of psychological phenomena, such as the spotlight effect (Gilovich, Medvec, & Savitsky, 2000), the illusion of transparency (Gilovich, Savitsky, & Medvec, 1998), and probability estimates (Fischhoff & Beyth, 1975; Hawkins & Hastie, 1991) (see Epley & Gilovich, 2001).

One early prediction of an anchoring and adjustment theory was that increased motivation should decrease the amount that an individual will anchor. For instance, if an individual is offered monetary compensation to provide an estimate that is as close as
possible to the true value, one would expect that they will more stringently test and adjust from an anchor value. Motivation may shift what answers one may find to be reasonable, and thus one may expect that a motivated individuals’ final estimates to be further away from an anchor values and closer to the true value. However, decades of research found that accuracy motivation tends not to produce a reduction in anchoring (for reviews see Chapman & Johnson, 2002; Epley & Gilovich, 2005; Tversky & Kahneman, 1974). Also, more recent work suggested that adjustment as a mechanism (i.e., starting at the anchor value and moving toward a range of plausible values) is relatively uncommon for experimenter-provided anchors (e.g., Epley & Gilovich, 2001, 2005). Because of these findings, the literature moved to a different account of anchoring relying on the knowledge that is activated when an anchor is considered (see Strack & Mussweiler, 1997).

Later evidence suggests that anchor and adjustment might still have explanatory power as a theory of anchoring by emphasizing a difference between self- and other-generated anchors. In a series of studies by Epley and Gilovich (2001, 2004, 2005, 2006), the authors found that increasing accuracy motivations did decrease anchoring with self-generated anchors, implying that anchor and adjustment might be involved (Epley & Gilovich, 2005). In addition, the authors found that participants would describe their thought process in assessing self-generated anchors in an anchor and adjustment fashion (Epley & Gilovich, 2001, Study 1). Further work on anchor and adjustment by Simmons, LeBoeuf, and Nelson (2010) has challenged the necessity of self-generated anchors to produce adjustment effects. The authors suggest that previous work on accuracy motivation has failed to take into account the uncertainty people have in the direction to
adjust from provided anchors. When certainty about the direction of adjustment is provided, individuals do seem to effortfully adjust away from even provided anchors (Simmons, LeBoeuf, & Nelson, 2010, Studies 2, 3a, 3b, and 5).

The anchor and adjustment process has important implications for increasingly extreme anchors, as compared to less extreme anchors. If an anchor is provided that is entirely plausible, one may expect little-to-no adjustment away from the anchor is necessary for that value to seem reasonable to people. However, if an anchor is rather extreme and implausible, further adjustment will be necessary for an individual to be comfortable endorsing an estimate based off of that anchor. Thus, the anchor and adjust heuristic would suggest that there should be more adjustment with an anchor that is far outside a range of plausible values than one that is within a range of plausible values, given that the implausible values are necessarily more extreme and provide more room for adjustment (unless both the outside and inside anchor values are close to the range boundary, in which case one would expect similar anchoring).

However, Quattrone and colleagues (1984) have suggested that people have a range of plausible values that they will use when making estimates, and that when an anchor lies beyond this range, people will adjust their estimate to the nearest boundary value. Thus, increasingly extreme anchors will lead to more anchoring than less extreme anchors, to a point. Once anchors are beyond the range of perceived plausibility, increasingly extreme anchors (e.g. increasingly implausible anchors) will result in the same amount of anchoring, as the most extreme estimate individuals will provide is their nearest boundary value of plausibility. For instance, Quattrone et al. (1984) found that people anchored as much with extreme anchors (e.g., whether the average temperature in
San Francisco was greater or less than 558 degrees Fahrenheit) as they did when the anchor values were more plausible.

*Selective Accessibility*

A more recent account of the process underlying anchoring is a selective accessibility approach (e.g., Strack & Mussweiler, 1997). The selective accessibility model suggests a hypothesis-testing strategy for anchoring, in which individuals first test a hypothesis that the anchor value is the correct answer. As people tend to evaluate hypotheses with confirmatory search (see Klayman & Ha, 1987), the testing of the anchor-based hypothesis disproportionately activates anchor-relevant information consistent with the provided anchor. Thus, anchor-relevant information is more accessible and attended to in the process of actually making a judgment, and this biases responses in the direction of the anchor. For example, considering an anchor of 70 degrees for a high temperature in Ohio brings to mind information that suggests that the average temperature for a day in Ohio may relatively mild, and this anchor-consistent information (such as memories of mild temperatures, or recalling that parts of Ohio border the Great Lakes) leads people to generate estimates closer to the anchor than if the anchor had not been considered.

This selective accessibility account seems to make unique predictions from the anchor and adjust view (see Chapman & Johnson, 2002), and the account avoids specific claims about motivational influences. Because the selective accessibility mechanism has been described as elaborative (Mussweiler & Strack, 2001), enhancing motivation could either decrease or increase anchoring effects depending on what information is activated.
when considering an anchor. The lack of specific motivational requirements is one reason that the selective accessibility account has been favored over anchor and adjustment as a broader explanation for how anchors affect judgments.

Evidence for a selective accessibility approach to anchoring is widespread, with Mussweiler and Strack (1998) finding faster responses for anchor-consistent words than anchor-inconsistent words on a lexical decision task following a comparative anchoring question. For example, comparing the price of a German car with a high anchor (e.g., 40,000 German Marks) increased the accessibility of expensive cars (e.g., “BMW”) but not cheap cars (e.g., “Volkswagen), and the reverse was true with low anchors. In addition, Mussweiler and Strack (1999) found that limiting the amount of knowledge a person can generate for the comparative task inhibits their capacity to make quick absolute judgments, implying that knowledge activated in a comparative judgment is used for the later estimation task.

The selective accessibility model suggests a similar mechanism to anchor and adjustment for implausibly extreme anchors. When exposed to an implausibly extreme anchor, the hypothesis test shifts from testing the anchor value as the correct answer to testing the nearest boundary of plausibility as the correct answer (Mussweiler & Strack, 1999). Mussweiler and Strack (1999) clearly emphasize this fact: “in particular, participants may process implausible anchors by first adjusting to the boundary value... and then testing the hypothesis that the object’s extension is equal to this boundary value.” Largely, this shift may be a result of individuals relying on more category or domain knowledge to answer the comparative question (e.g., general knowledge about the domain in which the target falls) and more specific, exemplar knowledge (e.g.,
knowledge about the target of the anchor) to make an estimate. Thus, if one’s category knowledge is such that a given anchor is outright beyond the highest possible value for that category, they may be very quick to reject an anchor (see Mussweiler & Strack, 2000).

As with anchor and adjust, this suggests that implausible anchors (e.g., an anchor that falls outside of one’s range of perceived plausible values) should lead to greater anchoring than plausible anchors (e.g., an anchor that falls within one’s range of perceived plausible values) because the anchor is much larger. Participants then engage in the same identical confirmatory search as they would with an anchor that falls at the boundary of their range of perceived plausible values. However, this process entails that increasingly implausible anchors should lead to no more anchoring than anchors that fall just outside the range of plausible values, given that the hypothesis tested for all implausible anchors is the same: that the nearest boundary of a range of plausible values is the correct answer.

Implausibility

Both the “anchor and adjust” and “selective accessibility” models suggest that implausible anchors should lead to more anchoring than plausible anchors. Both also suggest that increasingly implausible anchors should lead to no more anchoring than less implausible anchors (beyond the range of plausible values). That is, that there will be an asymptoting of anchoring to implausible values (see Figure 1). Indeed, Strack and Mussweiler (1999) found evidence consistent with both an asymptoting and a greater difference between two moderate anchors than between two extreme anchors. Further
evidence has been found for asymptoting in several studies that examined moderate and extreme anchors and found equal judgments, despite a great disparity in the actual value of the anchors (Chapman & Johnson, 1994; Northcraft & Neale, 1987). In addition, greater anchoring has been found for extreme anchors than nonextreme anchors (Strack & Mussweiler, 1997).

![Asymptoting of Anchoring](image)

Figure 1. Graph of asymptoting of anchoring at extremely high values. For any given value, when the extremity of the anchor is higher than the highest plausible value (e.g., 120), both selective accessibility and an anchor and adjust theories suggest an asymptoting of anchoring.

**Inconsistencies**

Although some studies have provided support for an asymptoting of anchoring to extreme values, a number of existing studies in the literature provide evidence somewhat
inconsistent with this perspective. Perhaps most notably, in Experiment 1 of Wegener, Petty, Detweiler-Bedell and Jarvis (2001), the authors found less anchoring with extreme anchors than with moderate anchors. In Experiment 2, the authors found that perceptions of plausibility mediated the effects of extremity of anchors on estimates. The authors also replicated the effect of extreme anchors showing less anchoring than moderate anchors, and, comparing across studies, the extreme anchors of Study 2 were more extreme than those of Study 1 and also showed less anchoring (Wegener et al., 2001). The results of these studies suggest not an asymptoting of anchoring but an inverted-U pattern across increasingly extreme high anchors.

Even some studies that initially seem supportive of an asymptoting of anchoring do not show an entirely clear pattern of results. For instance, in Experiment 1 of Chapman and Johnson (1994), the same amount of anchoring was found between moderate and extreme high anchors (consistent with an asymptoting of anchoring). However, the difference between low- and high-anchor conditions showed an increase in anchoring for the extreme anchors over the moderate anchors, because increasing extremity of low anchors continued to reduce judged values of the target gambles. In addition, in Experiment 2, high anchors that were even more extreme than the anchors in Experiment 1 produced greater anchoring; a result not in line with an asymptoting expectation of anchoring at such extreme values.

A final issue involves individual perceptions of plausibility. Both the anchor and adjust and selective accessibility accounts suggest an asymptoting of anchoring past some boundary of plausibility. However, in many previous studies on anchoring, actual perceptions of plausibility are unknown. Mussweiler and Strack (1999) define a plausible
value as a possible value for a member of a target category, and an implausible value as a value that constitutes an impossibly extreme value. However, without knowing if people perceive these values as being impossible or possible, it is still difficult to know whether they will engage with them as the anchor and adjust and selective accessibility models suggest that they will.

Continued Impact of Extreme Anchors

A key component of examining anchoring to extreme values is an individual’s perceived range of plausible values. This range construct has yet to be rigorously examined. In addition, both the anchor and adjust and selective accessibility models emphasize the importance of perceptions of plausibility of values related to the target category. That is, both models suggest certain specific processes about how individuals respond to anchors beyond the highest-lowest plausible and lowest-plausible values for a given question (e.g., the record high (hottest) temperature for a day in Seattle, Washington).

However, the aforementioned attitudinal view on anchoring (see Wegener et al., 2001) would suggest that anchoring functions similarly to a shift in attitudes in response to a persuasive appeal. In the attitudinal literature, increasingly extreme messages continue to persuade individuals until they are remarkably extreme, at which point one would expect a decrease in persuasion due to more counter arguing (e.g., Brock, 1967). For example, Bochner and Insko (1966) provided participants with an argument that suggested that people get some value between 8 and 0 hours of sleep per night. As the message became more extreme, and the advocated number of hours of sleep decreased,
participants’ beliefs continued to change in the direction of the message. Participants did not asymptote when the message became rather extreme (e.g., 1 or 0 hours of sleep). Instead, they were less persuaded by these messages than less extreme messages (e.g., 3 hours of sleep). In addition, when the message source was credible, this downturn did not occur until the extreme position of 1 hour of sleep was advocated.

Extending these findings by taking an attitudinal approach to anchoring allows the prediction of a continued impact of extreme anchors to rather implausible values. However, at very extreme values, one would expect a decrease in the impact of the anchors (which would conflict with an asymptoting view), but these downturns in anchoring need not be tied directly to boundaries of perceived plausibility of anchor values. This could allow for additional anchoring with extreme values before an eventual downturn in anchor effectiveness will occur. In sum, an attitude change model of anchoring would allow for both a continued impact of extreme anchors, outside of one’s range of plausible values, as well as a diminishment of anchoring at extreme enough values.

Overview of Studies

The present studies are designed to rigorously test the effects of increasingly implausible anchors, beyond people’s reported ranges of perceived plausibility, and the role that perceptions of target or domain plausible ranges have in anchoring. Both studies employed high anchors that were calculated based off of individual ratings of highest plausible values and are thus designed to be either the highest plausible value (e.g., at the boundary value of implausibility) or at varying levels of implausibility beyond this level.
of maximal-plausibility. In order to most closely use the Mussweiler and Strack (1999) definition of plausibility (i.e., possibility), participants in both studies were asked to provide estimates of possible values for the target judgment.
Chapter 2: Experiment 1

Methods

Participants and procedure. Participants were 120 undergraduates, either enrolled in an introductory psychology class at the Ohio State University or recruited on campus. In small groups of up to 8, the participants were asked to provide ranges of the “highest possible value” and “lowest possible value” for eight estimates, such as “The record high (hottest) temperature for a day in Seattle, Washington.” The lowest value was subtracted from the highest value for each individual participant to form a personalized range. This range was used to create personalized anchors. Four levels of personalized anchors were used, created individually, all of increasingly high extremity: (1) at the reported highest possible value, (2) at the highest possible value + (0.5 * size of range of possible values), (3) at the highest possible value + (1 * size of range of possible values), (4) at the highest possible value + (1.5 * size of range of possible values). The extremity of these anchors was varied within-subjects in a Latin square design, such that each participant received two anchors of each level of extremity over the course of the study. An individual’s least extreme anchors would be at the maximum possible value for a target category, and the other anchors would increase in extremity from there.

After a brief series of filler tasks, the participants then encountered the traditional anchoring paradigm, in which the participants first were asked to indicate whether they
believed the actual value was higher or lower than the anchor value (e.g., do you think the actual value is higher or lower than 200). Participants were then asked to make an estimate of what they believed the actual value of the item to be (e.g., what is the record high (hottest) temperature for a day in Seattle, Washington?)

*Standardization and Anchoring Value.* The scale of the eight items varied wildly (e.g., average attendance of a soccer game in Caracas, Venezuela versus the weight of the Roman Emperor Julius Caesar), and as such standardization was necessary to analyze the eight items under the same metric.

Thus a new measure was formed to both standardize participant responses as well as to take their initial range estimation into account. This ‘anchoring index’ consisted of the participants estimate, subtracting the lower boundary of the range, and dividing this deviation by the size of the range, for each target item Thus, if a participant was to provide a highest possible value of the weight of Julius Caesar of 2000 lbs., a lowest possible value of 50 lbs., and an estimate of 200 lbs., their anchoring value would be: 

\[
\frac{200 - 50}{2000 - 50} = 0.08.
\]

This value is the proportion of the participants estimate compared with their reported range of possible values. For example, a value of 1 would indicate that the participant’s estimate was at the top of their range (e.g., their highest possible perceived value), whereas a 0.5 would indicate that their estimate is the value that is the exact midpoint of their range (e.g., halfway between the highest and lowest possible values). Thus, the aforementioned 0.08 represents that the participants estimate only falls 8% above their lowest possible value within their range of possible values. This value is not bounded and could exceed 1, if their estimate is higher than what they initially reported as the highest possible value for that target.
Standardization to this personal range metric was performed for each item and for each of the 120 participants. After standardizing their scores, the participants’ two responses for each condition were averaged. The four composite scores were analyzed using a repeated measures one-way analysis of variance (ANOVA) with condition as a between-subjects factor (for variance).

*Tukey Outlier Analysis.* Prior to averaging of responses within condition for each participant, I used a fencing procedure based on Tukey (1977) in an effort to minimize the influence of outliers (see also Blankenship et al., 2008; Wegener et al., 2001). This fencing procedure does not remove outliers, but moves them to boundary values calculated using the interquartile range. The boundary value I used was Tukey’s “inner fence” of a normal distribution. The upper fence is the interquartile range multiplied by 1.5 added to the 75th percentile of the group of scores, and the lower fence is the interquartile range multiplied by 1.5 subtracted from the 25th percentile of the group of scores. This fencing procedure was enacted before standardizing responses. Out of 2320 responses, 152 responses were fenced, less than 7% of total responses.

*Results*

The one-way repeated measures ANOVA revealed a significant effect of anchor extremity, $F(3, 417) = 8.301, p < .001$. Post-hoc Bonferroni pairwise comparison tests revealed significant differences between levels 1 and 3 ($p < .001$), 1 and 4 ($p = .004$), and 2 and 3 ($p = .038$). Therefore, the results showed significant increases in the impact of anchors as they became more extreme (at least until the third level of extremity beyond reported ranges of possible values). In addition, a trend analysis produced a significant
linear trend of increasing amounts of anchoring across the four levels of anchor extremity, $F(1, 139) = 17.20, p < .001$. In order to ensure that the fenced values were not solely responsible for the results, I also examined median values of the four levels of extremity, which are not affected by fenced values. The median values for the four levels of extremity followed the same pattern as the mean values, which suggests that fencing the data was not driving the results, $Mdn\ 1 = 0.74; Mdn\ 2 = 0.90, Mdn\ 3 = 0.97, Mdn\ 4 = 0.92$.

Figure 2. One-way repeated measures ANOVA of four levels of extremity of implausible anchors.
Discussion

The results of this first study provide evidence for increasing anchoring at extremity levels beyond reported perceived possibility of the anchor value. This finding is largely inconsistent with theories that suggest an asymptoting of anchoring at extreme values, such as anchor and adjust and selective accessibility. However, a selective accessibility theorist may point to the lack of a difference between levels 3 and 4 as an indication that people will eventually asymptote in their responses, simply at more extreme levels than what they initially reported (perhaps due to a systematic underestimation of reported values at which they will perceive anchors as implausible). Another possibility is that these ranges of perceived plausibility are not entirely static, and just as estimates can be shifted by the anchors, so can the perceptions of plausibility or possibility of particular values between the initial range and the anchor value.

A key component of both anchor and adjust as well as selective accessibility models is the inviolability of movement of ranges of possibility. It seems that asymptoting of anchoring across levels of anchor extremity would only be predicted if the perceived range of plausible values would remain uninfluenced by the anchor value. For example, asymptoting would only occur as a result of hypothesis testing or bounding to the most extreme possible value if this most extreme possible value remains static over exposure to increasingly extreme anchors. As mentioned earlier, Mussweiler and Strack (1999) note that people process implausible anchors by “first adjusting to the boundary value of a distribution of plausible values and then testing the hypothesis that the object’s extension is equal to this boundary value.” However, if perceptions of possibility may shift as a result of anchoring, just as one’s estimations shift, then increasingly implausible
anchors may result in differential anchoring. Such a shift is not a component of the selective accessibility model, as Mussweiler and Strack (2001) later note “differentially extreme implausible anchors should produce similar absolute estimates, because adjustment from any implausible anchor should terminate at the same value.” If the selective accessibility model entailed a shift in ranges, it initially would not suggest an asymptoting at the same boundary value, or would also need to explicitly outline that this asymptoting occurs at some more extreme value. Both of these claims are absent in the literature.

Given that both category and exemplar knowledge may be used to address a given anchor (see Mussweiler & Strack, 2000), one may well expect that individuals have ranges of plausible values for both a target (e.g., record temperature in Seattle) as well as a domain (e.g., record temperature on Earth), and individuals may rely on the latter to inform the former. Examining the impact of both target and domain ranges could reveal important differences in how individuals respond to extreme values. Study 2 is the first study to directly address this possibility of dynamic ranges that shift in relation to an extreme anchor.
Chapter 3: Experiment 2

In a second data collection, we measured perceptions of ranges of plausible values both before and after participants received an anchor in order to specifically test whether perceptions of ranges were adjusted, along with estimates, after considering an anchor. Further, we measured both target and domain ranges, in an effort to more clearly elucidate whether a more general knowledge structure (e.g., knowledge of a domain) or specific knowledge about a target question were primarily used to inform participant responses. It also may be possible that participants’ target ranges shift when presented with an anchor about a target, whereas their beliefs about domain ranges are more static. It may well be that the shift in perceptions of plausibility of a range plays an important role in informing participants’ changing estimates across levels of anchor extremity.

Methods

Participants and procedure. Participants were 95 undergraduates, either enrolled in an introductory psychology class at the Ohio State University or recruited on campus. In small groups of up to 8, the participants were asked to provide ranges of the “highest possible value” and “lowest possible value” for four target estimates, such as “the height of the tallest mountain in North America (feet),” in an identical fashion to the first study. Only four items were used in this second study, as opposed to eight in the first study,
both due to time constraints, as well as due to the fact these four questions corresponded to domains about which people seemed most likely to have beliefs about the range of possible values for that domain. Participants were also asked to provide domain range estimates for four domain questions that corresponded to the target questions, such as “The height of the tallest mountain (feet).”

Participants were randomly assigned to see target items first or domain items first. Just as in the first study, target range estimates were used to form four levels of anchoring. In study two, this extremity was varied between-subjects. Participants followed the standard anchoring paradigm: they saw a comparative question (e.g., do you think the actual value is higher or lower than 200), and then reported their estimate of the actual value. After this estimate, participants again had to fill out ratings of the highest and lowest possible target and domain values for each of the target items.

*Standardization and Anchoring Value.* Standardization was performed for each item and each of the 95 participants, in an identical fashion to the first study. The four scores were averaged to make a single dependent variable that was analyzed using a one-way between-subject analysis of variance (ANOVA).

*Tukey Outlier Analysis.* In an effort to minimize the influence of outliers, we employed the fencing procedure from Tukey (1977), in an identical fashion to the first study. Out of 3800 responses, 361 responses were fenced, 9.5% of total responses.

*Results*

The one-way ANOVA revealed a significant differences between the four levels of anchoring on participant estimates, \( F(3, 91) = 7.04, p < .001 \). Post-hoc Bonferroni
multiple comparisons tests revealed significant differences between levels 1 and 3 \((p = .02)\) and 1 and 4 \((p < .001)\). In addition, a significant linear trend of increasing amounts of anchoring across the four levels was found, \(F(1, 91) = 20.90, p < .001\). Again, in order to ensure that the fenced values were not solely responsible for the results, median values were examined. The median values for the four levels of extremity followed the same pattern as the mean values, which suggests that fencing the data was not driving the results, \(Mdn\ 1 = 0.84; Mdn2 = 1.06, Mdn3 = 1.10, Mdn\ 4 = 1.48\). A one-sample t-test even revealed that the most extreme anchors (level 4) led to judgments \((M = 1.4951)\) that were significantly higher than a value of 1, which those same participants had previously reported as the highest possible value for the target, \(t(23) = 4.64, p < .001\).

It is worth noting that the means of the anchoring index in this second study were quite a bit higher than the first study (e.g., the highest value in the first study [.9933] was between the two lowest cell means in this second study). This may be a function of participants not receiving varying levels of extremity within-subjects, but only between-subjects. Having more mixed levels of extremity may temper the extremity of possibility participants are willing to consider, and in the absence of more ambiguously-extreme information, people are inclined to provide more extreme values.

In addition to the significant differences between extremity levels on estimates, the higher boundaries of the post-anchor ranges were investigated. A series of basic ANOVAs revealed that the extremity of the anchors significantly predicted both the higher boundary (e.g., closest to the anchor) of the post-anchor target range, \(F(3, 90) = 4.33, p < .01\), and the higher boundary of the post-anchor domain range, \(F(3, 88) = 4.53, p = .01\). Moreover, the higher boundaries of the post-anchor target and domain ranges,
respectively, both predicted the participants’ estimates, $F(1, 92) = 23.64, p < .001$; $F(1, 90) = 18.98, p < .001$. A series of ANOVAs revealed that the extremity of the anchors did not significantly impact the lower boundary (e.g., furthest from the anchor) of the post-anchor target range, $F(3, 90) = .419, p = .74$, nor of the post-anchor domain range $F(3, 88) = .974, p = .41$.

![Amount of Anchoring at Varying Levels of Extremity](image)

Figure 3. One-way ANOVA of four levels of extremity of implausible anchors.
Some initial evidence for a mediation model was found as when both the extremity of the anchor and the higher boundary of the target range were in the model predicting the estimate. The anchor extremity term dropped in significance (p < .001 to p = .012), whereas the higher boundary significance did not drop (p = .0003 to p = .0003). Initial evidence for domain mediation was also found when the level of anchor extremity and the higher boundary of the domain range were in the model. Anchor extremity dropped in significance from p < .001 to p = .002, whereas the higher boundary significance value did not drop (p = .0004 to p = .0004).

A multiple mediation test using a bootstrapping method designed by Preacher and Hayes (2008) was employed to simultaneously test the mediation path working through the higher boundaries of the post-anchor target and domain ranges on the estimate. With both higher boundaries in the model, the effect of anchor extremity on the estimate dropped from \( B = 0.22, t(92) = 4.60, p < .001 \) to \( B = 0.16, t(92) = 3.29, p = .001 \). The level of anchor extremity significantly predicted both the higher boundary for the target range, \( B = 0.24, t(92) = 3.54, p < .001 \), as well as the higher boundary for the domain range, \( B = 0.10, t(92) = 2.43, p = .02 \). However, the impacts of both of the higher boundaries on the final estimates were marginally significant: target, \( B = 0.16, t(92) = 1.88, p = .06 \); domain, \( B = 0.14, t(92) = 1.94, p = .02 \). Using a bootstrapping procedure to test the indirect effects, the indirect effect was significant using a 95% confidence interval for both the higher boundary of the target, \( B = .037, [0.0040, 0.0920] \), as well as domain, \( B = .027, [0.0009, 0.0755] \), consistent with shifts in both boundary values mediating the impact of extremity level on estimates.
Running the same procedure using the higher boundaries of the post-anchor target and domain ranges revealed no change in the effect of anchor extremity on the estimate, \( B = 0.22, t(92) = 4.60, p < .001 \) to \( B = 0.22, t(92) = 4.55, p < .001 \). The bootstrapping procedure revealed that the indirect effect of the lower boundaries was not significant using a 95% confidence interval, target: \( B = -.0017, [-.019, .012] \); domain: \( B = .0004, [-.073, .033] \). This suggests that the movements of the higher boundaries of possible values, those closest to the anchor, were most affected by the anchor and are driving the impact of anchor extremity on participant estimates.

Figure 4. Path diagram of multiple mediation test of the higher boundaries of the post-anchor target and domain ranges.

Rather than shifts in perceptions of plausibility influencing the impact of anchors on judgments, a critic might argue that people are instead shifting their estimate based on
an anchor, and then forming a range around this moved estimate. Without pre-anchor estimates, it is impossible to directly test this possibility. However, if this was the case, one would likely expect that the proportion of one’s post-anchor range that their estimate falls into would be close to 0.5 (i.e., their anchoring index using post-anchor ranges would be near the midpoint). However, analyzing both a target and domain post-anchor index reveals that for target ranges values of $M = 0.75$, $SD = 0.41$, and for domain ranges values of $M = 0.37$, $SD = 0.55$. Thus it appears that people’s estimates are around the upper one-quarter of their post-anchor target range, and their estimates are around the lower one-third of their post-anchor domain range, and that their estimate is not near the midpoint of either. In addition, if participants were forming a range around their estimates, both the upper and lower boundaries would likely shift to higher values to accommodate the higher estimate. However, as mentioned earlier, the level of extremity of the anchor did not impact the lower boundaries.

Discussion

The results of Study 1 were largely replicated in Study 2, insofar as people continued to show anchoring with values more extreme than their highest reported plausible value. However, in this second study, the mean values for the four levels of extremity are higher than in the first study. The higher anchoring seen in this study may be a result the differences in study design, namely that in Study 2 participants were presented with information in a between-subjects fashion, and received only anchors of a certain extremity level instead of at multiple levels.
In addition, anchors were found to influence perceptions of plausible values and one’s post-anchor perceptions of these values for both target and domain ranges predict the amount of anchoring an individual engages in. As participants’ target ranges were generally smaller than their domain ranges, they may be able to expand or shift these ranges post-anchoring while maintaining a similar domain range. This could explain the independent influence of the target upper boundary on estimates. If some participants shift their domain range given extreme anchors, they also may be more inclined to shift their target boundary. However, if some participants shift their domain boundary very little, they may be reluctant to shift their target boundary so close to the domain boundary, which could explain the independent influence of the domain upper boundary on estimates. Both of these situations would create independent target and domain means, and may explain why the target and domain higher boundaries acted as multiple mediators between anchor extremity and estimates.

Lastly, the post-anchor target and domain ranges do not appear to simply be constructed around one’s estimate, but are somewhat independently affected by the anchor.
Chapter 4: Discussion

The effects of increasingly extreme anchors, beyond perceptions of highest possible values, were examined across two separate data collections. The data from Study 1 reveal a pattern of results largely inconsistent with existing theories of how individuals use extreme anchors, insofar as a trend of increasing anchoring was found for anchors of four levels beyond perceptions of highest possible values. This result was replicated in a second study, and in addition, this second study provided evidence that the upper boundaries of these ranges also shift. In addition, these shifts in perceived ranges of plausible (possible) values, post-anchoring, mediated the impact of the level of anchor extremity on estimates.

These two studies made two main assumptions about the selective accessibility and anchor and adjust models of anchoring: (1) that ranges are considered static by these accounts, and (2) that these ranges may be adequately tapped by asking people what they perceive as impossible. Proponents of these theories may claim that either of these two claims is not true. Dynamic ranges would represent a change in how the theories consider ranges, but a systematic underestimation of range boundaries by participants might not be. However, given that participants were asked about possible values, rather than plausible ones, it seems difficult to believe that even a half-range value above what they predicted as impossible was not reaching the top of what they perceived as plausible prior
to the anchoring task.

As mentioned earlier, a key component to both a selective accessibility and anchor and adjust theory of asymptoting anchoring perceived ranges of plausibility would seem to be the existence of static ranges. Even though the authors of selective accessibility and anchor and adjust did not explicitly state that these range values are static, this seems to be a core component for how they formulated their hypotheses relating to extreme anchors. However, the results from the second study seem to indicate that participants’ perception of the nearest boundary to an anchor are not static, but in fact are susceptible to anchoring effects, and this susceptibility largely drives the impact of the extremity of the anchor on the estimate. Indeed, some preliminary evidence from Study 2 suggests that rather than merely form a range centered around an anchored estimate, the anchors themselves are affecting the range boundaries. The asymmetric placement of the estimate within these post-anchor estimates seems unlikely to occur otherwise. In order to rigorously test the exact influence of the estimate on the ranges, additional data on pre-anchoring estimates is necessary.

Further work needs to be done to examine whether there is a limit to how far ranges of perceived plausibility can be stretched. It seems likely that even extreme anchors can pull perceptions of plausibility only so far. However, when anchors are extreme enough to no longer influence ranges of plausibility, it is not clear that one’s estimates would begin to asymptote; instead, an inverted-U pattern of results is also possible (see Wegener et al., 2001). This downturn may well be reflected on the effects of anchor extremity on range boundaries as well. An attitudinal perspective (Wegener et al., 2001) has suggested that individuals may eventually engage in a disconfirmatory search
for anchor-inconsistent information given extreme enough anchors, which would indicate not an asymptote but eventually a decrease in anchoring.

As always, extending anchoring further may reveal important distinctions in what processes individuals use when considering different anchors. The present work indicates that common theories of anchoring have an incomplete picture of how individuals actually engage with extreme anchors. The impact these anchors have on perceptions of plausible ranges, and the impact these ranges have on the amount individual’s anchor, have yet to be fully explored. There may be any number of moderators that could influence the impact of anchors on ranges, and ranges on estimates. For instance, confidence in a boundary value may limit the malleability of the range boundary, and thus could limit the impact of the anchor on one’s estimate, independent of one’s confidence in their domain knowledge of an item. Differential knowledge of domain or target ranges could also result in differential shifts in post-anchor ranges, and the impact of these ranges on one’s estimate.

Thus, the present work is only the first in investigating the precise results of anchoring to extreme values. In addition, the possibility of ranges of plausibility shifting due to anchoring was investigated, along with how these shifts impact amount of anchoring. The studies serve to both further elucidate anchoring mechanisms when at extreme anchor values are encountered, as well as to raise further questions about when and how individuals anchor to extreme values. Many of these questions are now open to be answered by further research.
References


Heuristics and biases: The psychology of intuitive judgment (pp. 120–138).


