Research Article

PUTTING ADJUSTMENT BACK IN THE ANCHORING AND ADJUSTMENT HEURISTIC:
Differential Processing of Self-Generated and Experimenter-Provided Anchors

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Abstract—*People's estimates of uncertain quantities are commonly influenced by irrelevant values. These anchoring effects were originally explained as insufficient adjustment away from an initial anchor value. The existing literature provides little support for the postulated process of adjustment, however, and a consensus that none takes place seems to be emerging. We argue that this conclusion is premature, and we present evidence that insufficient adjustment produces anchoring effects when the anchors are self-generated. In Study 1, participants' verbal reports made reference to adjustment only from self-generated anchors. In Studies 2 and 3, participants induced to accept values by nodding their heads gave answers that were closer to an anchor (i.e., they adjusted less) than participants induced to deny values by shaking their heads—again, only when the anchor was self-generated. These results suggest it is time to reintroduce anchoring and adjustment as an explanation for some judgments under uncertainty.*

In what year was George Washington elected president? What is the freezing point of vodka? Few people know the answers to these questions, but most can arrive at a reasonable estimate by tinkering with a value they know is wrong. Most know that the United States declared its independence in 1776, so Washington must have been elected sometime after that. And most know that alcohol freezes at a lower temperature than water, so vodka must freeze at something colder than 32 °F. To answer questions like these, in other words, people may spontaneously anchor on information that readily comes to mind and adjust their response in a direction that seems appropriate, using what Tversky and Kahneman (1974) called the *anchoring and adjustment heuristic*. Although this heuristic is often helpful, adjustments tend to be insufficient, leaving people's final estimates biased toward the initial anchor value.

To examine this heuristic, Tversky and Kahneman (1974) developed a paradigm in which participants are given an irrelevant number and asked if the answer to a question is greater or less than that value. After this comparative assessment, participants provide an absolute answer. Countless experiments have shown that people's absolute answers are influenced by the initial comparison with the irrelevant anchor. People estimate that Gandhi lived to be roughly 67 years old, for example, if they must first decide whether he died before or after the age of 140, but they estimate that he lived to be only 50 years old if they must first decide whether he died before or after the age of 9 (Strack & Mussweiler, 1997).

Anchoring effects have been demonstrated in numerous contexts, including the evaluation of gambles (Carlson, 1990; Chapman & Johnson, 1994; Schkade & Johnson, 1989), estimates of risk and uncer-

tainty (Plous, 1989; Wright & Anderson, 1989), perceptions of self-efficacy (Cervone & Peake, 1986), anticipations of future performance (Switzer & Sniezek, 1991), and answers to general knowledge questions (Jacowitz & Kahneman, 1995). Anchoring and adjustment has also figured prominently as an explanatory mechanism underlying such diverse phenomena as preference reversals (Lichtenstein & Slovic, 1971; Schkade & Johnson, 1989), probability estimates (Fischhoff & Beyth, 1975; Hawkins & Hastie, 1991), trait inference (Gilbert, 1989; Kruger, 1999), language production and comprehension (Keysar & Barr, in press), and various egocentric biases such as the spotlight effect (Gilovich, Medvec, & Savitsky, 2000) and the illusion of transparency (Gilovich, Savitsky, & Medvec, 1998).

Anchoring effects have traditionally been interpreted as a result of insufficient adjustment from an irrelevant value (Tversky & Kahneman, 1974), but recent evidence casts doubt on this account. Instead, anchoring effects observed in the standard paradigm appear to be produced by the increased accessibility of anchor-consistent information (Mussweiler & Strack, 1999, 2000; Strack & Mussweiler, 1997). The attempt to answer the comparative question—say, whether Gandhi lived to be 140—leads an individual to test the hypothesis that the irrelevant anchor value is correct—did Gandhi live to 140? Because people evaluate hypotheses by attempting to confirm them (Crocker, 1982; Snyder & Swann, 1978; Trope & Bassok, 1982), such a search will generate evidence disproportionately consistent with the anchor. The absolute judgment is then biased by the evidence recruited in this confirmatory search. This alternative account, accompanied by failures to demonstrate a process of adjustment, has led some researchers to conclude that "anchoring occurs because of biased retrieval of target features," and not because of insufficient adjustment (Chapman & Johnson, in press; see Mussweiler & Strack, 1999, in press, for a discussion of anchoring effects with and without adjustment).

We believe this conclusion is premature. In particular, we suggest that just as memory research was sidetracked by an overly persistent analysis of people's ability to recall nonsense syllables, so too has anchoring research been sidetracked by an overly persistent analysis of people's responses in the standard anchoring paradigm. Outside this paradigm, anchors are often self-generated, rather than provided by an experimenter or other external source. People know George Washington was elected after 1776, but how long after? People know that vodka freezes at less than 32 °F, but how much less? Externally provided anchors, even outrageous ones, differ from self-generated anchors because they have to be taken seriously, if only for a moment. Self-generated anchors, in contrast, are known—from the beginning—to be wrong. There is thus no cause to consider whether the anchor value is correct and thus no engine of heightened accessibility of anchor-consistent information. This difference led us to propose that anchoring effects are produced by insufficient adjustment rather than selective accessibility when the anchor is self-generated. We investigated this possibility in three experiments.

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STUDY 1

In our initial exploration, participants verbalized their thoughts when answering questions involving self-generated and experimenter-provided anchors. We predicted that participants would describe a process of anchoring and adjustment only when anchors were self-generated. In these cases, we expected that the verbal reports would typically begin with a reference to the anchor value, followed by a statement describing adjustment away from it (e.g., "The United States declared its independence in 1776 and it probably took a few years to elect a president, so Washington was elected in . . . 1779"). In contrast, we expected experimenter-provided anchors to produce little or no mention of either the anchor or adjustment, consistent with the selective-accessibility account of anchoring effects in the standard paradigm (Strack & Mussweiler, 1997).

Method

Fifty Cornell undergraduates were each asked four questions. Two questions were ones for which most participants could be counted on to generate a particular anchor value (e.g., "When did the second European explorer, after Columbus, land in the West Indies?"—1492), and two involved anchors provided by the experimenter (one high value and one low value; see Table 1).

Participants were asked to explain how they arrived at the answer to each question. Their responses were recorded, transcribed, and evaluated by two raters who were unaware of our hypotheses. For each response, the rater evaluated whether the participant appeared to know the anchor value, used the anchor as a basis of the answer, and mentioned adjustment from the anchor to arrive at a final estimate. Interrater agreement was .94. A third rater who was also unaware of our hypotheses resolved disagreements. Participants were considered to have utilized anchoring and adjustment only if their verbal reports referred to both the anchor and a process of adjustment.

Results and Discussion

As predicted, participants were more likely to describe a process of anchoring and adjustment when the anchor values were self-generated than when they were provided by the experimenter. Of those partici-

pants who appeared to know both self-generated anchors ($n = 34$), 94% made reference to anchoring and adjustment in response to at least one of the self-generated items, and 65% did so in response to both. In contrast, only 22% of the participants ($n = 50$) described anchoring and adjustment in response to at least one of the experimenter-provided anchors, and only 4% did so in response to both (see Table 1).

To assess the statistical significance of these results, we calculated the percentage of items for which participants reported a process of anchoring and adjustment for the self-generated and experimenter-provided items. Four participants were excluded from this analysis because they knew neither of the self-generated anchors. As predicted, participants were far more likely to report using anchoring and adjustment when considering self-generated anchors ($M = 73.9\%$) than when considering experimenter-provided anchors ($M = 13.0\%$), paired $t(45) = 8.56, p < .0001$.

These results indicate that self-generated anchors activate different mental processes than experimenter-provided anchors. One might be concerned, however, about relying on participants' self-reports given the widespread doubts about whether people can accurately report on their own mental processes (Nisbett & Wilson, 1977). One might also be concerned about a Gricean alternative interpretation of these findings. That is, participants may have been less likely to mention the experimenter-provided anchor value and how they adjusted from it because the anchor value was already mentioned in the initial comparative question. Note that this interpretation is rendered less plausible by the fact that the same pattern of results was obtained when we scored participants' responses for statements of adjustment only, rather than statements of the initial anchor value and adjustment. Nevertheless, we conducted the following studies—which manipulated the process of adjustment rather than assessing it—to rule out this explanation completely.

STUDY 2

When people adjust from self-generated anchors, they may do so in one of two ways. One possibility is that people "slide" along some mental scale, continuously testing until they arrive at a satisfactory final estimate. More plausible, we believe, is that they "jump" some amount from the anchor—analogous to a saccade in reading—to a more reasonable value and assess its plausibility. If the new value

Table 1. *Percentage of participants describing a process of anchoring and adjustment in Study 1*

Question	n	Percentage describing anchoring and adjustment
Self-generated anchor		
When was Washington elected president?	42	64
When did the second European explorer, after Columbus, land in the West Indies?	37	89
Experimenter-provided anchor		
What is the mean length of a whale?	50	12
What is the mean winter temperature in Antarctica?	50	14

Note. Although 50 participants were included in this experiment, the number of participants varies for the items with self-generated anchors because not all participants knew the relevant anchor (i.e., the date of Columbus's arrival in the West Indies or the date of the Declaration of Independence). The anchor value provided was 69 ft for the mean length of a whale and 1 °F for the mean winter temperature in Antarctica.

seems plausible, adjustment stops. If it does not seem plausible, a new jump or saccade is made, the new value is assessed, and so on.

Regardless of the continuous or discrete nature of adjustment, anything that influences participants' thresholds for accepting or denying values that come to mind should influence the amount of adjustment. If a participant is more willing to accept values, he or she will terminate the adjustment process more quickly and provide a final estimate that is closer to the original anchor value. If a participant is less accepting, he or she should continue to adjust and arrive at a final estimate further from the anchor.

We sought to influence participants' thresholds for acceptance or denial by using the tried-and-true influence of motor movements on attitudes and persuasion (Cacioppo, Priester, & Berntson, 1993; Forster & Strack, 1996, 1997; Martin, Harlow, & Strack, 1992; Priester, Cacioppo, & Petty, 1996). Previous research has demonstrated that people are more likely to accept propositions when they are nodding their heads up and down than when they are shaking them from side to side (Wells & Petty, 1980). We reasoned that asking participants to nod their heads would make them more willing to accept values that initially came to mind, and thus produce less adjustment from self-generated anchors. Shaking their heads from side to side, in contrast, would make participants more willing to reject values, and thus produce more adjustment from self-generated anchors. Because of this difference in adjustment, we also predicted that participants would generate an answer more quickly when nodding than when shaking their heads.

Because nodding and shaking should not systematically influence the selective accessibility of anchor-consistent information, we predicted these head movements would not influence answers to questions with externally provided anchors.

Method

Participants ($n = 50$) were told that the experiment was a study of product evaluations, and that they would be asked to evaluate a set of headphones while moving their heads from side to side or up and down in order to assess the headphones under everyday use.

All participants listened to a tape containing 16 anchoring questions. To justify this procedure and reduce suspicion, the experimenter explained that she wished to examine "implicit evaluations" that people "form without conscious intention or effort." She thus needed to busy participants with another task while they were evaluating the headphones, in this case by answering the questions on the tape. Depending on a random schedule, participants were then asked to nod their head up and down, shake their head from side to side, or hold their head still.

The experimenter, who was unaware of our hypotheses, provided a brief demonstration of the desired head movement for each participant, situated herself behind the participant, readied a stopwatch, and began the tape. She recorded the answer to each question as well as the time required to generate each answer.

The 16 anchoring questions, which were presented in a fixed order, were divided into blocks of 4. In order to maintain the cover story, the experimenter stopped the tape after each block and asked the participant to evaluate the headphones. All questions in the first three blocks involved self-generated anchors (e.g., "How long does it take Mars to orbit the sun?"—365 days), with participants completing one block while randomly performing each of the head movements.

The last block contained four anchoring questions taken from Jacowitz and Kahneman (1995). Participants repeated the head move-

ment made during the first block, and the experimenter recorded their answers and reaction times to the comparative and absolute components of each question. Because we were interested in adjustment, and not anchoring effects per se, we did not manipulate the experimental anchor for each question. We selected the four items that produced the largest anchoring effects in the study by Jacowitz and Kahneman, and provided high anchor values for two questions and low anchor values for the other two (e.g., "Is the population of Chicago more or less than 200,000? What is Chicago's population?").[1]

Following this procedure, participants completed a questionnaire that asked directly about the intended anchor value for each item involving a self-generated anchor (e.g., "In what year did the United States declare its independence?") and whether they had considered this value when generating their answer.

Results and Discussion

Two preconditions had to be met for an adequate test of our hypotheses about self-generated anchors. First, participants had to know the self-generated anchor. Second, they had to report considering the anchor when making their estimate. Participants who did not meet these preconditions were excluded on an item-by-item basis. On three questions, fewer than 30% of participants met both preconditions, generally because they did not know the intended anchor value. In some cases, this left no participants in one or more of the experimental conditions. We therefore dropped from the analyses three questions (about the fastest mile, death of the first apostle, and orbit of Io). This left nine questions with self-generated anchors (three in the first block, four in the second, and two in the third).[2,3]

To determine whether head movements influenced participants' responses, we converted answers to each question to standard scores and then averaged across all items within each head-movement condition. Reaction times were logarithmically transformed to reduce skew, then standardized and averaged in the same fashion. Answers to the four items that required downward adjustment were reverse-scored so that, as for the other questions, higher scores on this index reflected a larger discrepancy between the anchor and final answer. As can be seen in Table 2, a repeated measures analysis of variance on this composite measure indicated that participants' head movements significantly influenced their answers to the items with self-generated anchors,

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1. A complete list of the questions used in all experiments can be obtained from the authors.

2. On two of the remaining items, the gestation period of an African elephant and the orbit of Mars, not all participants adjusted in the right direction from the intended anchor (i.e., some believed Mars travels around the sun in fewer than 365 days, or that an elephant's gestation period is less than 9 months). Because we were interested in the process of adjustment, we used the absolute difference between the reported anchor and final answer on these items. Higher numbers on these adjustment scores indicate a larger discrepancy between the anchor and final answer, or larger adjustment. The same procedure was employed on all of the items with experimenter-provided anchors, for the same reason. Note, however, that the results in both this study and Study 3 were unchanged when participants' raw estimates, rather than adjustment scores, were used for the items with experimenter-provided anchors.

3. Some participants confused Fahrenheit with Celsius, reporting 100° as the boiling point of water ($n = 14$) or 0° as its freezing point ($n = 4$). The responses of these participants were converted to degrees Fahrenheit.

Anchoring and Adjustment

Table 2. *Mean standardized answers and reaction times in Study 2*

Measure	Head movement			$F\,(p)^a$
	Nodding	Still	Shaking	
Self-generated anchors ($n = 43$)				
Answer	−.21	−.07	.15	3.89 (.02)
Reaction time	−.27	−.10	.17	5.67 (.005)
Experimenter-provided anchors ($n = 50$)				
Answer	.16	−.25	.07	3.10 (.05)
Reaction time	.01	−.03	.02	0.03 (n.s.)

^{a}For items with self-generated anchors, $df = 2, 84$; for items with experimenter-provided anchors, $df = 2, 47$.

$F(2, 84) = 3.89, p < .05$. A follow-up contrast showed that participants provided answers closer to the self-generated anchor (i.e., they adjusted less) when they were nodding their heads than when they were shaking their heads, $F(1, 42) = 6.44, p < .05$. Participants gave responses in between those in these two conditions when they were holding their heads still. Responses to individual items, in raw scores, are presented in Table 3.

Participants' head movements also influenced the speed with which they generated their answers to the questions with self-generated anchors, $F(2, 84) = 5.67, p < .05$. As predicted, participants answered more quickly when nodding than when shaking their heads, $F(1, 42) = 11.76, p < .01$. The latency of participants' responses was an intermediate value when they were holding their heads still.

We contend that participants adjusted from self-generated anchors in a serial fashion and that head movements influenced their responses by altering their willingness to accept values that came initially to mind. Participants were more willing to accept values that initially came to mind while nodding their heads, producing less adjustment and faster reaction times than when they were shaking their heads. This mechanism differs considerably from the selective-accessibility mechanism that appears to explain anchoring effects in response to experimenter-provided anchors, suggesting that different psychological processes may be operating in these two contexts. Results for the questions with experimenter-provided anchors are consistent with this contention: Table 2 shows that participants' head movements did not have the same influence on responses to these items.[4]

STUDY 3

Because the strikingly different impact of head movements on responses to questions with self-generated versus experimenter-provided anchors is the only evidence of its kind of which we are aware, we thought it prudent to replicate these results. We thus conducted a close replication with two changes: (a) We used equal numbers of items with self-generated and experimenter-provided anchors, and (b) we

counterbalanced the order in which these items were presented. These changes permitted us to conduct a direct statistical test of the differential effect of head movements on the two types of questions.

Method

Thirty-two Cornell students participated in a procedure identical to that of Study 2 except that only 8 questions (4 each with self-generated and experimenter-provided anchors) were used instead of 16, and there was no control condition with no head movement. The questions with self-generated anchors were from Study 2, and the questions with experimenter-provided anchors were from Jacowitz and Kahneman (1995)—2 holdovers from Study 2 and 2 new items.

The four items within each anchor type were split into pairs, producing two self-generated pairs and two experimenter-provided pairs. Participants answered one pair of each item type while nodding their heads, and the other while shaking them. The order in which questions were presented was counterbalanced and did not influence any of the results. After each pair, participants evaluated the headphones as part of the cover story. As in Study 2, participants completed a questionnaire at the end of the session so we could ascertain their knowledge of the self-generated anchors, and whether they had considered these anchors when making their estimates.

Results and Discussion

Individual responses were excluded and the data were transformed in the same manner as in Study 2. Two participants failed to satisfy the inclusion criteria on at least one item type, leaving 30 participants in the final analysis.

Participants' responses to each item were standardized within each block, and responses were averaged across item type. Participants' scores were submitted to a 2 (anchor: self-generated vs. experimenter-provided) × 2 (head movement: nodding vs. shaking) repeated measures analysis of variance. This analysis yielded a marginally significant main effect of head movement, $F(1, 29) = 3.89, p = .06$, qualified by the predicted significant interaction, $F(1, 29) = 9.38, p < .01$. As can be seen in Table 4, participants' answers were more discrepant from a self-generated anchor when they were shaking versus nodding their heads, paired $t(29) = 3.61, p < .005$. Responses to specific items, in raw scores, are presented in Table 5.

In contrast to the results for the items with self-generated anchors, head movements did not influence responses to the items with experimenter-provided anchors, paired $t < 1$, n.s.[5]

A similar, although considerably weaker, pattern emerged in an analysis of participants' response latencies. As can be seen in Table 4, participants were somewhat faster to provide answers to the items with self-generated anchors when they were nodding their heads than when they were shaking them, paired $t(29) = 1.52, p = .14$. Head movements had no influence on reaction times to questions with experimenter-provided anchors, paired $t < 1$. The overall interaction between type of question and amount of time required to generate an answer, however, was nonsignificant, $F(1, 29) < 1.77, p = .19$.

These data replicate those of Study 2 and demonstrate more conclusively that self-generated anchors activate a different set of mental

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4. Participants' head movements did not influence their comparative judgments (i.e., whether they believed the true value was higher or lower than the experimenter-provided anchor), $F < 1$, n.s.

5. As in Study 2, participants' head movements also did not influence their comparative judgments, paired $t(31) = 1.49, p = .15$.

Table 3. *Mean responses to items with self-generated anchors in Study 2*

			Head movement		
Question	*n*	Anchor	Nodding	Still	Shaking
When was Washington elected president?	37	1776	1777.60	1779.10	1788.10
What is the boiling point of water on Mt. Everest?	32	212	189.31	173.99	141.41
When did the second European explorer, after Columbus, land in the West Indies?	46	1492	1501.88	1514.36	1548
How many states were in the United States in 1840?	38	50	36.75	30.42	31.64
What is the freezing point of vodka?	38	32	17.36	1.75	−9.55
What is the highest recorded body temperature in a human being?	40	98.6	108.34	110.17	107.47
What is the lowest recorded body temperature in a human being?	44	98.6	75.18	83.17	77.65
How many days does it take Mars to orbit the sun?[a]	37	365	127.89	99.36	202.60
What is the gestation period of an African elephant? (months)[a]	45	9	8.50	6.06	5.54

[a]The data presented for these items are adjustment scores (the absolute difference between the participant's answer and his or her reported anchor) because a number of people adjusted in each direction from the self-generated anchors on these items. Lower numbers indicate a smaller discrepancy between the final answer and the original anchor (i.e., less adjustment).

operations than experimenter-provided anchors. Head movements influenced responses when anchors were self-generated but not when they were provided by the experimenter.

GENERAL DISCUSSION

The results of these experiments reestablish the existence of both anchoring and adjustment in some judgments under uncertainty. When questions activate self-generated anchors, people adjust from those anchors to arrive at final estimates. This process differs considerably from the processes involved when anchors are provided by an experimenter or other external source, demonstrating that there are distinct anchoring effects produced by different mechanisms. We therefore second Jacowitz and Kahneman's (1995) call for a careful taxonomy of the varieties of anchoring effects in order to advance psychologists' understanding of this pervasive element of judgment under uncertainty.

The present experiments have identified the anchor's source as one important feature of that taxonomy—a feature that makes it possible to distinguish those anchoring effects that are produced by a process of adjustment and those that are not. It is noteworthy in this regard that a number of phenomena that have been explained through a process of

anchoring and adjustment seem to rely on self-generated anchors similar to those that we studied here. These phenomena include trait inference (Gilbert, in press), interpersonal communication (Keysar & Barr, in press), comparative ability estimates (Kruger, 1999), and various egocentric biases (Gilovich et al., 1998, 2000; Keysar & Bly, 1995; Van Boven, Dunning, & Loewenstein, 2000). Trait inferences begin with a dispositional attribution that observers generate themselves; similarly, communication, comparative ability estimates, and the processes involved in a host of egocentric judgments begin with a spontaneous consideration of one's own comprehension, skills, or perspective on the world. Final judgments in these cases are thus likely the product of insufficient adjustment from these self-generated anchors. Note that many of these phenomena are amplified by cognitive-load manipulations designed to hinder any underlying process of adjustment (Gilbert, in press; Kruger, 1999)—manipulations that have no effect on responses in the standard anchoring paradigm (Epley & Gilovich, 2000a).

Do adjustments from self-generated anchors tend to be insufficient? Research on trait inference suggests that although people try to adjust their impressions to accommodate situational influences, they adjust too little and are left inferring more about a person's disposition than is logically warranted (Gilbert, in press). Research on comparative ability estimates paints a similar picture: Although people try to adjust for others' ability level, they adjust too little and are left feeling systematically above average in domains where absolute skill tends to be high, such as driving, and below average in domains where it tends to be low, such as juggling (Kruger, 1999). Results from the control condition of Study 2 suggest that adjustments in numerical estimates also tend to be insufficient. Participants in that condition estimated that George Washington, for example, was elected president in 1779 although he was actually elected in 1788. They also estimated that vodka freezes at 1.75 °F although it actually freezes closer to –20 °F. Indeed, we have reported elsewhere that people tend to systematically fall short of the actual answer when adjusting from self-generated anchors (Epley & Gilovich, 2000b).

This research provides the first compelling evidence that anchoring effects can be produced by a process that includes adjustment. And although the adjustment process is anything but fully understood, its existence now seems apparent.

Table 4. *Mean standardized answers and reaction times in Study 3*

	Head movement		
Measure	Nodding	Shaking	*t* (*p*)
Self-generated anchors (*n* = 30)			
Answer	−.27	.33	3.61 (.001)
Reaction time	−.16	.07	1.52 (.14)
Experimenter-provided anchors (*n* = 32)			
Answer	.04	−.07	< 1 (n.s.)
Reaction time	−.04	.02	< 1 (n.s.)

Table 5. *Mean answers to items with self-generated anchors in Study 3*

Question	*n*	Anchor	Head movement Nodding	Head movement Shaking
When was Washington elected president?	28	1776	1783.50	1788.25
When did the second European explorer, after Columbus, land in the West Indies?	30	1492	1508.72	1534.42
What is the boiling point on Mt. Everest?	21	212	192.50	176.90
What is the freezing point of vodka?	28	32	12.47	−19.09

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