Available online at www.sciencedirect.com
ScienceDirect
Cognition 106 (2008) 13–26
COGNITION
www.elsevier.com/locate/COGNIT

Anchors aweigh: A demonstration of cross-modality anchoring and magnitude priming☆, ☆☆

Daniel M. Oppenheimer [a,*], Robyn A. LeBoeuf [b], Noel T. Brewer [c]

[a] *Department of Psychology, Princeton University, Green Hall, Princeton, NJ 08544, USA*
[b] *Marketing Department, University of Florida, PO Box 117155, Gainesville, FL 32611, USA*
[c] *306 Rosenau Hall, University of North Carolina, CB #7440, Chapel Hill, NC 27599, USA*

Received 26 May 2005; revised 4 December 2006; accepted 6 December 2006

Abstract

Research has shown that judgments tend to assimilate to irrelevant "anchors." We extend anchoring effects to show that anchors can even operate across modalities by, apparently, priming a general sense of magnitude that is not moored to any unit or scale. An initial study showed that participants drawing long "anchor" lines made higher numerical estimates of target lengths than did those drawing shorter lines. We then replicated this finding, showing that a similar pattern was obtained even when the target estimates were not in the dimension of length. A third study showed that an anchor's length relative to its context, and not its absolute length, is the key to predicting the anchor's impact on judgments. A final study demonstrated that magnitude priming (priming a sense of largeness or smallness) is a plausible mechanism underlying the reported effects. We conclude that the boundary conditions of anchoring effects may be much looser than previously thought, with anchors operating across modalities and dimensions to bias judgment.

☆ This manuscript was accepted under the editorship of Jacques Mehler.
☆☆ The authors thank Pam Sawyer, Sara Etchison, Benoît Monin, Teenie Matlock, Eliot Berkman, Dedre Gentner, Danny Kahneman, and Adele Goldberg for their insightful suggestions and assistance.
* Corresponding author. Tel.: +1 609 258 7465.
E-mail address: doppenhe@princeton.edu (D.M. Oppenheimer).

0010-0277/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.cognition.2006.12.008

Keywords: Anchoring; Priming; Judgment; Physical quantities; Cross-modal; Assimilation

1. Introduction

How long is the Mississippi River? An individual could use a number of cues to help answer such a question, and those cues vary in usefulness. Relevant information, such as the fact that the Mississippi is the longest river in North America or that it runs from Minnesota to the Gulf of Mexico, provides a useful cue for estimating length. However, irrelevant information, such as the fact that Samuel Clemens (a.k.a. Mark Twain, the most famous author to write about the Mississippi) was born in 1835, is not useful. An individual making a judgment may be exposed to a mix of such relevant and irrelevant cues. Ideally, the individual would not be biased by the irrelevant information, and intuitively, the individual might not expect such bias to arise. Unfortunately, mounting evidence suggests that such irrelevant and arbitrary cues can indeed influence judgments.

In particular, a phenomenon described in the literature as *anchoring* (Chapman & Johnson, 1994; Strack & Mussweiler, 1997; Tversky & Kahneman, 1974) illustrates how estimations can be biased by the consideration of irrelevant information. In a classic study, Tversky and Kahneman (1974) asked participants whether the result of a spin on a number-generating "wheel of fortune" exceeded or fell short of the percentage of African countries in the United Nations. Subsequent estimations of the actual percentage of African countries in the UN were biased by the results of the spin; high spins led to higher estimates, and low spins led to lower estimates. This pattern of effects has been documented in numerous contexts, and anchoring is agreed to be a quite robust phenomenon (see Chapman & Johnson, 1994, for review).

There is less consensus about the boundary conditions for anchoring. That is, at what point will a piece of information no longer influence an individual's judgments? Some researchers argue that anchors will have greater influence on judgments to the extent that the anchors might be informative about the to-be-estimated quantity (e.g., Moore & Brown, submitted for publication). This view is supported by evidence that anchoring effects are greatly reduced, and often disappear, if the anchor and target do not refer to the same dimension (Chapman & Johnson, 1994). Along similar lines, Strack and Mussweiler (1997) found that while an anchor expressed in terms of height influenced participants' estimates of the height of the Brandenburg Gate, it had a markedly reduced influence on estimates of the Gate's width.

In contrast, other research suggests that anchoring may be more prevalent. There is ample evidence that implausible (hence, clearly uninformative) anchors can still bias estimates (Chapman & Johnson, 1994); for example, participants estimating the average temperature of San Francisco were influenced by an anchor of 558 degrees (Quattrone et al., 1984). Furthermore, researchers have demonstrated "basic anchoring:" merely exposing an individual to a number can bias estimates in the number's direction, even if the number is never explicitly linked to the judgment being made (e.g. Wilson, Houston, Brekke, & Etling, 1996). While such basic anchoring effects are fragile, they have been effectively replicated several times (Brewer & Chapman, 2002), further casting doubt on the requirement that anchors must be informative. Further evidence attests to anchoring's pervasiveness: Incentives for accuracy do not seem to eliminate anchoring effects (Brewer, Chapman, Schwartz, & Bergus, in press; Tversky & Kahneman, 1974; Wilson et al., 1996) nor do explicit warnings about the possibility of being biased by anchors (Quattrone et al., 1984; Wilson et al., 1996).

Furthermore, anchors can come in many, not necessarily numerical, forms (see, e.g., Kruger, 1999). Indeed, even physical quantities can serve as anchors for physical judgments: Participants attempting to draw a previously seen line produced a shorter line when they extended a short "anchor" line than when they reduced a long line, even when no numbers were attached to the line lengths (LeBoeuf & Shafir, 2006). This evidence, in combination with reports of basic anchoring effects, suggests that anchoring may be much more widespread than previously believed.

In this paper, we propose to further extend the known scope of anchoring effects. Given that merely being exposed to an anchor can bias unrelated judgments, and that physical quantities such as lines can serve as anchors, we hypothesize that physical anchors might function *cross-modally* to bias numerical judgments. In particular, we propose that large or small anchors may prime the notion of their general magnitudes (e.g., "largeness" or "smallness") and that the activated sense of magnitude may be influential when judges next form an estimate, leading to an anchoring effect. That is, merely activating a sense of size, unattached even to a rating scale, may bias subsequent judgments to be consistent with that activated size, regardless of the modality of judgment. Hence, cross-modal effects of anchors may arise, with a large anchor in any one modality leading to a large judgment in any other (or the same) modality.

Other previously documented processes leading to anchoring would not predict such cross-modal effects on judgments. Numerical priming (Wilson et al., 1996) requires the presence of a numerical anchor. The presentation of that anchor ostensibly makes that number and others near it (e.g., on a number line) more accessible and results in anchoring in subsequent judgments. Note that we predict that cross-modal anchoring would arise even without numerical anchors. Another process, insufficient adjustment (Epley & Gilovich, 2001; Tversky & Kahneman, 1974), suggests that one generates an estimate by starting at, and adjusting from, an anchor that is a potential estimate of the target. However, this explanation requires the anchor and target to be on the same rating dimension (otherwise adjusting from anchor to target would not, strictly speaking, be possible).

Still another mechanism, selective knowledge accessibility (Chapman & Johnson, 1994, 2002; Strack & Mussweiler, 1997), holds only when an anchor can be credibly argued to selectively activate knowledge about the target. That is, exposure to a low or high magnitude anchor would have to selectively activate ideas related to *the target* being small or large: for example, when asked whether the mean temperature in Germany is higher or lower than 5 degrees, participants may retrieve information consistent with 5 degrees being the true answer and with Germany being rather cold; this, in turn, may create relatively low estimates of Germany's temperature (Mussweiler & Strack, 1999). However, such activation of information about the target seems unlikely if the anchor is evaluated in one modality and the target in another; it is unclear how the evaluation of a short or long line, for example, would selectively activate specific thoughts about the temperature in Germany, or in any other place.

If, however, anchors activate general notions of "largeness" or "smallness" (independent of any given target or response scale), one would expect judgments to be biased by anchors, even cross-modally when the anchor cannot prime a number, serve as the basis for adjustment, or activate knowledge about the target. To explore the hypothesized existence of cross-modal anchoring effects, Experiment 1 investigated whether exposure to a large physical stimulus (an unnumbered long line) prompts greater numerical estimates of a target quantity than exposure to a small physical stimulus.

2. Experiment 1

2.1. Methods

Participants. Seventy-one Stanford University undergraduates participated to fulfill part of a course requirement. The experiment consisted of two questionnaires in a packet of approximately 20 unrelated one-page questionnaires. Packets were randomly ordered and then distributed in class, and participants were given a week to complete the entire packet.

Design, stimuli, and procedure. Participants were presented with a set of three horizontal lines and were asked to replicate the lines as best as they could without using a ruler. The three lines were a straight line, a wavy line, and an inverted-u. Participants in the short-anchor condition replicated 1-in. long lines, while participants in the long-anchor condition replicated 3.5-in. lines. The stimuli are reproduced in Fig. 1.

On the next page, participants were presented with an ostensibly unrelated judgment task in which they were asked to estimate various quantities. The target quantity, the length of the Mississippi River, was always asked about first; several decoy questions followed to prevent participants from guessing the hypothesis. Six participants who gave estimates falling more than 3.5 standard deviations from the mean were excluded as outliers.

2.2. Results and discussion

Participants who drew long lines gave an average estimate of 1224 miles whereas participants who drew short lines gave an average estimate of 72 miles. This difference was statistically reliable, $t(63) = 2.61$, $p < .05$.

Participants who had been anchored by copying long lines reliably estimated the river to be longer than those anchored with short lines. In other words, not only can anchoring occur when no explicit comparison is made between an anchor and a target (cf. Wilson et al., 1996), it can even arise across modalities. This suggests that modality cannot be counted among the boundary conditions of

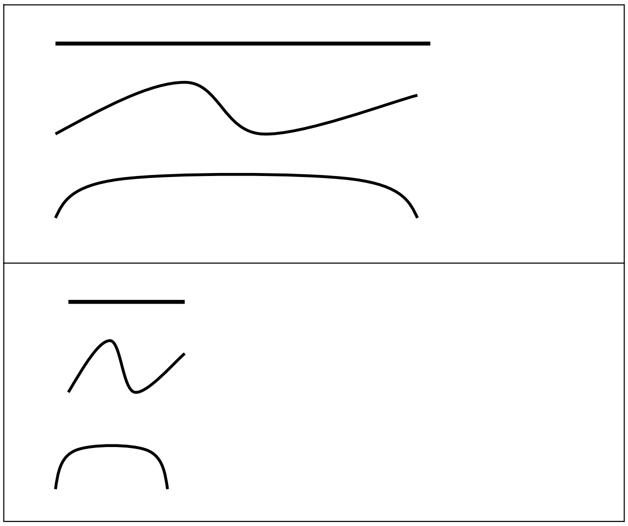

Fig. 1. The long and short lines used as anchors in Experiments 1, 2, and 4.

the anchoring phenomenon, and that anchoring effects may be more prevalent than previously thought.

Although Experiment 1 demonstrated cross-modality anchoring effects, it did so within a single dimension: length. Participants were anchored on lines of varying lengths and then made estimates of length. This finding does not address whether anchoring effects persist when anchors and targets are not in compatible dimensions, a topic about which there has been some debate (e.g., Strack & Mussweiler, 1997). For example, Chapman and Johnson (1994) found that anchors expressed in terms of dollar amounts did not influence life-expectancy estimates. Similarly, Kahneman and Knetsch (1993) found that dollar anchors did not influence subsequent judgments reported in percentages. Given such literature on anchor-target compatibility, it is plausible that cross-modality anchoring effects may not extend across physical dimensions. Experiment 2 investigated this possibility by presenting physical anchors that varied in length and then asking for numerical estimates in a different dimension, in this case, temperature. If cross-modality anchoring operates across dimensions, with anchors priming general notions of largeness and smallness (and not just specific ideas about length), temperature estimates should increase as participants are exposed to longer lines.

3. Experiment 2

3.1. Methods

Participants. Ninety-eight individuals recruited from arbitrarily chosen intersections in San Francisco participated in exchange for a candy bar.

Design, stimuli, and procedure. The anchoring procedure and stimuli were identical to Experiment 1. However, instead of estimating the length of the Mississippi River, participants were asked to estimate the average temperature in Honolulu in July in degrees Fahrenheit. As in Experiment 1, participants were also asked several decoy estimation questions to disguise the experiment's true aim. Two participants were excluded as outliers, as their estimates fell more than 3.5 standard deviations from the mean.

3.2. Results and discussion

Participants who drew long lines gave an average estimate of 87.5 degrees. Participants who drew short lines gave a reliably lower average estimate of 84.0 degrees, $t(94) = 2.05, p < .05$.

Participants who had initially drawn long lines reliably gave warmer temperature estimates than those who had drawn short lines, indicating that anchoring occurs both cross-modally and across dimensions. This is somewhat surprising in light of previous studies that found reduced anchoring effects when targets and anchors were from incompatible domains or dimensions (Chapman & Johnson, 1994; Kahneman & Knetsch, 1993; Strack & Mussweiler, 1997). It is certainly possible that the anchor had less of a biasing effect for temperature (average difference of 3.5 degrees, Cohen's $d = 0.42$) in Experiment 2 than it did for length in Experiment 1 (average difference of 504 miles, Cohen's $d = 0.66$), but because the dimensions are so disparate, such comparisons are tenuous.

4. Experiment 3

At this point, the data suggest that cross-modality anchoring has the potential to be fairly prevalent. The first two experiments suggest that anchors from one dimension or modality could indeed influence estimates of targets in another dimension or modality. Even so, such effects must have boundaries.

One such boundary might be found in how people conceive of "large" and "small." Size is a relative concept, which varies based on context (Birnbaum, 1999; Cruse, 1986; Denes-Raj & Epstein, 1994). A pencil is long in comparison with a toothpick, but short when compared to the Golden Gate Bridge. In these studies, a 3.5-in. line is long relative to the width of a page, and a 1-in. line is short relative to the width of a page. However, if the context were altered, one might be able to make stimuli of the same absolute size have different relative meanings, and, conversely, to make stimuli of different absolute sizes have the same relative meaning. This in turn could influence the effectiveness of those stimuli as anchors.

Experiment 3 investigated whether manipulating contextual cues can influence the ability of physical anchors to operate cross-modally. Consider two irregular lines, one that is approximately 4.5 in. long and another that is approximately 1.5 in. long. Since one line is larger relative to the size of a standard page than is the other, if each line is presented in isolation on a sheet of paper, the lines will evoke notions of largeness and smallness, respectively. Under such conditions, the lines should effectively anchor judgments. However, next imagine that the long and short lines appear to be rivers inside of large or small maps of the United States. Given that the impression of size is indeed heavily influenced by context, the lines should appear to be approximately the same *relative* size (that is, relative to the appropriately scaled map). Under *these* conditions, one map-embedded line should not evoke a greater sense of "largeness" than the other, and anchoring effects should be greatly reduced.

4.1. Methods

Participants. One hundred sixty-four Princeton University undergraduates participated in exchange for monetary compensation.[1] The survey was included in a packet of approximately 30 unrelated one-page questionnaires. Participants completed the entire packet in approximately 1 hour.

Design, stimuli, and procedure. Four conditions were used: Anchor length (long or short) was crossed with context (map or no map). For the "map" conditions, a map of the United States that displayed state borders but contained no text or labels was digitally adjusted to create two sizes. The small map was 2.875 in. wide by 1.875 in. tall, whereas the large map was 8.875 in. wide by 6.125 in. tall. Regardless of map size, participants were instructed to trace the path of the Mississippi River on the map; "start" and "end" points were marked so that participants would know where on the map to look for the Mississippi.

To create "no map" conditions, we digitally isolated the path of the Mississippi from the maps, so that participants were presented with either a small or a large Mississippi-shaped line that was the exact size of the river in the small- and large-map conditions, respectively. Participants were told that the line was copied from a map and that it illustrated the shape of the Mississippi; they were asked to copy the line to recreate the river's path.

Thus, in two conditions participants drew a small river and in two they drew a large one, with the key manipulation being whether the river was shown in the context of a map. All participants were then asked to estimate the length of the Mississippi River (on the same page on which the line had been drawn). Two participants in the map condition were excluded for ignoring the start and end points and drawing the wrong river. Six additional participants were excluded as outliers for giving estimates more than 3.5 standard deviations from the mean.

4.2. Results and discussion

Estimates were subjected to a 2 (anchor: short or long) $\times$ 2 (map: present or absent) ANOVA. This ANOVA revealed a main effect of map, $F(1, 152) = 11.40$, $p = .001$, but more importantly, it revealed the predicted interaction between map

[1] This study was replicated in Central Park in New York City and in a questionnaire packet at the University of Florida, and the trends were consistent.

presence and anchor length, $F(1,152) = 6.56$, $p < .05$. To parse this interaction, we consider first the no-map condition. When the anchors were presented without context, the average estimate of the Mississippi River was 899.9 miles after drawing the short line, and a reliably greater 1367.8 miles after drawing the long line, $t(79) = -2.94$, $p < .01$, Cohen's $d = 0.66$. This pattern of effects replicates the findings from Experiment 1. However, when context for the lines was provided by the maps, the power of the lines to serve as anchors disappeared: in fact, estimates of the Mississippi River were slightly and non-significantly *greater* following short lines ($M = 1541.2$) than long ($M = 1455.6$, $t(73) = .59$, $p > .10$, Cohen's $d = 0.14$). The results are summarized in Fig. 2.

Thus, as expected, in the absence of a map, participants who had drawn long lines gave longer estimates of the Mississippi than did participants who had drawn shorter lines, consistent with the idea that long lines prime the general idea of largeness, whereas short lines prime smallness. However, when the same lines were placed on a map such that they were the same length relative to the context, no differences were observed. Another way to consider these data is to recall the main effect of the map context: estimates increased when the lines' link to a real geographic feature was highlighted. Thus, "mapping" the lines onto the US seems to have led the lines to evoke notions of greater magnitude than they evoked in the context of a blank page, even though their absolute lengths remained unchanged. Particularly striking is the finding that estimates following a short line noticeably increased (899.9 vs. 1541.2, $t(77) = -4.31$, $p < .001$) when that line was contextualized to clearly represent a substantial portion of the "length" of the US.

Thus, when both lines were placed in appropriately scaled contexts, the lines came to evoke similar perceptions and to have similar impacts on length judgments. More generally, it seems that anchors only exert effects to the extent that they are perceived as differentially small and large relative to the context. When contexts equalize the anchors' relative sizes, the anchors cease to have a differential impact on judgments, presumably because they no longer differentially provoke perceptions of largeness and smallness.

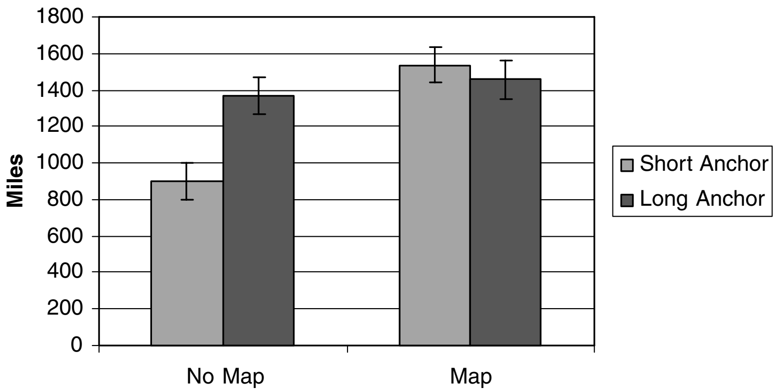

Fig. 2. Results from Experiment 3. The efficacy of anchors depends upon the context in which those anchors are presented.

5. Experiment 4

We have asserted that anchors may activate ideas related to their relative magnitudes (e.g., "large" or "small") and that such activated knowledge then influences responses to subsequently encountered stimuli, leading to the cross-modal anchoring observed here. Although the research presented up to this point is certainly consistent with this contention, Experiment 4 was designed to provide more direct support for this mechanism by showing that large and small anchors differentially activate semantic notions of magnitude.

In particular, Experiment 4 employed a word-completion task (cf. Tulving, Schacter, & Stark, 1982) to detect more directly whether anchors prime ideas related to size (cf. Bassilli & Smith, 1986; Higgins, 1996). We predicted that large anchors would be more likely than small anchors to activate thoughts about largeness and would consequently prompt more completed fragments that are synonymous with "large".

5.1. Methods

Participants. One hundred ninety-eight University of Florida students participated for extra course credit. The experiment consisted of two questionnaires embedded within a packet of unrelated questionnaires.

Design, stimuli, and procedure. As in Experiments 1 and 2, participants were first asked to replicate a set of (long or short, randomly assigned) lines without using a ruler. We used the lines shown in Fig. 1, but the assigned set of long or short lines appeared three times on the anchoring page, so that participants replicated either nine long lines or nine short lines. We employed the additional lines to increase the power of the anchors because we anticipated the word completion task to be less sensitive than the measures used in our previous studies.

On the next page was an ostensibly unrelated "Word Completion Study" with the following instructions:

> Please fill in the missing letter in each word below in order to complete the word. Do this as fast as possible, using the first word that comes to mind. Note: Proper nouns are NOT allowed.

Seven words, each missing one letter, were then presented. Three of the words were target words that could be completed to create a synonym for "large": _ONG (LONG), B_G (BIG), _ALL (TALL). The target words could also be completed to create words unrelated to magnitude (e.g., SONG, BUG, BALL). The remaining four filler words could not be completed to refer to magnitude: GLA_(e.g., GLAD), _EN (e.g., HEN), PO_(e.g., POT), K_YS (e.g., KEYS). Word order was counterbalanced.

5.2. Results and discussion

Responses to each target word were coded as "1" if a synonym for "large" was provided and were coded as "0" otherwise. We summed participants' scores across the three target words, so that participants could earn scores ranging from 3 (if a participant used a synonym for "large" for each target word) to 0 (if a participant used no synonyms for "large"). Participants who had been exposed to the long anchors responded to the target words with, on average, 1.6 synonyms for "large," whereas participants who had been exposed to the small anchors responded with an average of 1.3 synonyms for "large," $t(196) = 2.42$, $p = .02$, Cohen's $d = 0.35$. The effect is small but reliable, and, notably, the effect falls in the same direction for each of the three target words: in the long-anchor condition, 50% of participants wrote "long," 79% wrote "big" and 26% wrote "tall," but those percentages dropped to 42%, 70%, and 16%, respectively, in the short-anchor condition.

Thus, the experiment supports our contention that anchors activate mental representations of magnitude that are independent of target or rating scale. Because differences in responses to a word-completion task are generally taken as evidence of recent knowledge activation or priming (cf. Bassilli & Smith, 1986), the current results suggest that concepts relating to largeness are more likely to be activated for those who encounter long anchors than for those who encounter short anchors. This finding supports our proposed mechanism and sheds light on cross-modal anchoring: long (short) lines are more likely to activate the general idea of largeness (smallness). Such activated impressions of magnitude then remain accessible when people must judge whether subsequently encountered stimuli, including river lengths and temperatures, are relatively large (small).

6. General discussion

In three experiments, anchors in one modality influenced estimates made in another modality. Long physical anchors increased numerical estimates; this occurred not only with estimates along the (similar) dimension of length, but also with estimates in the (dissimilar) dimension of temperature. Far from anchors needing to be relevant to the estimate at hand, it seems that anchors can have subtle yet pervasive influences on judgments that are quite disparate in topic and form. A fourth experiment found that longer lines primed the broad mental representation of large magnitudes.

That said, one boundary condition that can be placed on cross-modality anchoring is that context is an important determinant of whether an anchor will influence judgments. It is not the absolute size of an anchor that drives the effect, but rather the perception of its relative size (Wong & Kwong, 2000). To that end, one would expect large anchors to exert less of an upward bias in contexts where many things in the environment are large.

Undoubtedly, contextual understanding of size is not the only boundary condition on cross-modality anchoring. For example, Chapman and Johnson (2002) proposed that individuals need to focus attention on the anchor in order for the anchor to have an effect. In the present experiments, participants had their attention explicitly drawn to the anchors. If the anchors had merely been one part of an unattended-to background, it is unclear whether the anchors would have been interpreted as large and small (as required by our model). It seems unlikely that merely being exposed to a line without attending to it would bias estimates, but the possibility remains open to empirical testing.

Additionally, anchoring effects likely only exist when people are estimating quantities not readily available or calculable. Most people do not know the exact length of the Mississippi nor Honolulu's average July temperature. Hence, such estimates are susceptible to anchors. However, anchors would presumably not bias a person's ability to solve a simple arithmetic problem or report a known fact such as the current year (Wilson et al., 1996) or the temporal distance until a prominent holiday (LeBoeuf & Shafir, 2006). One would similarly presume that cross-modal anchoring would not impact estimations of known quantities.

Thus, we have shown that physical anchors influence numerical estimates. To further explore the generality of the cross-modality anchoring, we conducted a follow-up study to examine whether physical estimates could, in turn, be biased by numerical anchors. We asked participants ($N = 86$) to complete a questionnaire packet that contained our two-page experiment. The first (anchoring) page presented participants with a series of trivia questions. Most of the questions were decoys identical between conditions, but the final question served as an anchor. Some participants were asked if the Mississippi River was longer than 15 miles, whereas others were asked if that river was longer than 4800 miles. On the next page, in an ostensibly unrelated task, participants were asked to draw a line the length of a standard toothpick and then to draw several other "filler" shapes.

Participants who had seen the large anchor drew toothpicks that were larger ($M = 2.19$ in.) than those who had seen the small anchor ($M = 2.08$ in.). This difference approached reliability, $t(78) = 1.7$, $p < .05$ one-tailed, Cohen's $d = 0.39$. (Six participants who incorrectly answered the trivia question regarding the length of the Mississippi River were excluded from this analysis.) Thus, this study, while not conclusive, is indeed suggestive that the effects documented here are quite general and that cross-modality anchoring can work bidirectionally, with physical anchors influencing numerical estimates, and numerical anchors influencing physical estimates.

The experiments reported here bear more than a passing resemblance to those Wilson et al. (1996) used to obtain *basic anchoring*. In their studies, anchor numbers were presented in a variety of innocuous ways, and those numbers biased later answers about wholly unrelated topics (e.g., copying a series of 35 four-digit numbers biased later estimates of cancer incidence). Our line-copying task is analogous to their repetitive number copying exercise, but an important difference is that in our studies, the anchor and target were in different modalities, with physical anchors biasing estimates of a numerical target. The difference has theoretical implications for explaining basic anchoring. The extension of the findings to the physical domain suggests that basic anchoring may not be due to numerical priming as Wilson et al. (1996) hypothesize (see also Wong & Kwong, 2000). Instead, our findings suggest that anchors may prime some notion of "largeness" or "smallness" that is independent of any number or target but is itself highly context dependent.

Furthermore, our effect is unlikely to be driven by other theoretical mechanisms previously proposed for anchoring. In the selective-accessibility framework, comparison of an anchor to a target is thought to trigger activation of anchor-congruent knowledge about the target (Chapman & Johnson, 1994, 2002; Strack & Mussweiler, 1997). Such biased activation then distorts later judgments about the target. This explanation is not applicable to the present findings, however, because drawing an abstracted line is highly unlikely to instigate comparison to, let alone to activate knowledge of, a target such as the average temperature in Honolulu (cf. Wilson et al., 1996).

Insufficient adjustment from a (possibly informative) anchor (Epley & Gilovich, 2001; Tversky & Kahneman, 1974) is not a likely explanation in this case for similar reasons; the anchors in our studies literally cannot be considered a starting point for target estimation. It is difficult to determine what number people would anchor on (and subsequently adjust away from) when, for example, estimating temperature after seeing an abstracted line.

The experiments we present call for a novel theoretical explanation beyond those presently in the anchoring literature. The studies support the notion of a free-standing representation of magnitude that is activated by an anchor. Thinking about a relatively short line (or a small number) primes smallness while thinking about a relatively long line (or a large number) primes largeness. A key word in that conclusion, though, is "relatively:" when the two anchors are placed onto a metric that equates them (e.g., a rescaled map of the U.S.), they no longer cue different notions of magnitude.

The account we offer should not be construed as a rival hypothesis to the other major theories of anchoring; the present model cannot account for many of the findings associated with insufficient adjustment and selective knowledge accessibility. At the same time, we do not rule out the possibility that the phenomenon we document may operate simultaneously with other previously reported anchoring mechanisms. It seems plausible that the phenomenon of anchoring has several underlying processes and that magnitude priming is just one part of a bigger picture.

In sum, the present findings suggest that the boundaries of anchoring effects may be much wider than previously thought. Not only do irrelevant numbers influence judgments, but so might irrelevant shapes, sounds, temperatures, and weights. This has implications across a wide variety of domains. Students filling out class evaluation forms might have lower evaluations of the class if the forms are completed with golf pencils rather than regular pencils. The fact that the taller candidate won 80% of the presidential election contests between 1904 and 1980 (Gillis, 1982) could be due partly to the fact that their heights biased people's estimates of their positive qualities. Waiting in a long line to get tickets at the theater may bias people to then think that the cost of theater popcorn is not exorbitant. This is hardly an exhaustive list; clearly, there are many far-reaching applications and implications of these findings.

Judgments are not made in a vacuum. People making judgments have access to a tremendous number of potentially influential internally generated and externally provided cues. Research on anchoring has demonstrated that it is very hard to ignore such cues, even when they are completely irrelevant to the judgment at hand. Understanding how people incorporate or exclude irrelevant information when making judgments plays an essential role in understanding cognition and is a necessary step towards helping people make better judgments. Finally, although we do believe that cross-modal anchoring effects are fairly wide-ranging, we hope the brevity of this paper does not bias judgments about the import of our findings!

References

Birnbaum, M. (1999). How to show that 9 > 221: Collect judgments in a between-subjects design. *Psychological Methods, 4*, 243–249.

Bassilli, J. N., & Smith, M. C. (1986). On the spontaneity of trait attribution: Converging evidence for the role of cognitive strategy. *Journal of Personality and Social Psychology, 50*, 239–245.

Brewer, N. T., & Chapman, G. B. (2002). The fragile basic anchoring effect. *Journal of Behavioral Decision Making, 15*, 65–77.

Brewer, N. T., Chapman, G. B., Schwartz, J., & Bergus, G. R. The influence of irrelevant anchors on the judgments and choices of doctors and patients. *Medical Decision Making*, in press.

Chapman, G. B., & Johnson, E. J. (1994). The limits of anchoring. *Journal of Behavioral Decision Making, 7*, 223–242.

Chapman, G. B., & Johnson, E. J. (2002). Incorporating the irrelevant: Anchors in judgments of belief and value. In T. Gilovich, D. W. Griffin, & D. Kahneman (Eds.), *The psychology of judgment: Heuristics and biases*. New York: Cambridge University Press.

Cruse, D. A. (1986). *Lexical semantics*. Cambridge: Cambridge University Press.

Denes-Raj, V., & Epstein, S. (1994). Conflict between intuitive and rational processing: When people behave against their better judgment. *Journal of Personality and Social Psychology, 66*, 819–829.

Epley, N., & Gilovich, T. (2001). Putting adjustment back in the anchoring and adjustment heuristic: Divergent processing of self-generated and experimenter provided anchors. *Psychological Science, 12*, 391–396.

Gillis, J. (1982). Too small, too tall. Champaign, IL: Institute for Personality and Ability Testing, Inc.

Higgins, E. T. (1996). Knowledge activation: Accessibility, applicability, and salience. In E. T. Higgins & A. W. Kruglanski (Eds.), *Social psychology: Handbook of basic principles* (pp. 133–168). New York: The Guilford Press.

Kahneman, D., & Knetsch, J. (1993). Strong influences and shallow influences: An analysis of some anchoring effects. Unpublished manuscript, University of California, Berkeley.

Kruger, J. (1999). Lake Wobegon be gone! The "below average effect" and the egocentric nature of comparative ability judgments. *Journal of Personality and Social Psychology, 77*, 221–232.

LeBoeuf, R. A., & Shafir, E. (2006). The long and short of it: Physical anchoring effects. *Journal of Behavioral Decision Making, 19*, 393–406.

Moore, S. E., & Brown, N. R. Examining the influence of disclaimers on adoption of numerical anchors: Evidence supporting a Gricean interpretation of anchoring effects, submitted for publication.

Mussweiler, T., & Strack, F. (1999). Hypothesis-consistent testing and semantic priming in the anchoring paradigm: A selective accessibility model. *Journal of Experimental Social Psychology, 35*, 136–164.

Quattrone, G. A., Lawrence, C. P., Warren, D. L., Souza-Silva, K., Finkel, S. E., & Andrus, D. E. (1984). Explorations in anchoring: The effects of prior range, anchor extremity, and suggestive hints. Unpublished manuscript, Stanford University, Stanford, CA.

Strack, F., & Mussweiler, T. (1997). Explaining the enigmatic anchoring effect: Mechanisms of selective accessibility. *Journal of Personality and Social Psychology, 73*, 437–446.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science, 185*, 1124–1131.

Tulving, E., Schacter, D. L., & Stark, H. (1982). Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 8*, 336–342.

Wilson, T. D., Houston, C. E., Brekke, N., & Etling, K. M. (1996). A new look at anchoring effects: Basic anchoring and its antecedents. *Journal of Experimental Psychology: General, 125*, 387–402.

Wong, K., & Kwong, J. (2000). Is 7300 m equal to 7.3 km? Same semantics but different anchoring effects. *Organizational Behavior and Human Decision Processes, 82*, 314–333.