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Elaboration and consequences of anchored estimates: An attitudinal perspective on numerical anchoring

Kevin L. Blankenship [a], Duane T. Wegener [b,*], Richard E. Petty [c], Brian Detweiler-Bedell [d], Cheryl L. Macy [b]

[a] Department of Psychology, California State University – Fresno, USA
[b] Psychological Sciences Department, Purdue University, 703 Third Street, West Lafayette, IN 47907-2081, USA
[c] Department of Psychology, Ohio State University, USA
[d] Department of Psychology, Lewis and Clark College, USA

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ABSTRACT

In the standard numerical anchoring paradigm, the influence of externally provided anchors on judgment is typically explained as a result of elaborate thinking (i.e., confirmatory hypothesis testing that selectively activates anchor-consistent information in memory). In contrast, theories of attitude change suggest that the same judgments can result from relatively thoughtful or non-thoughtful processes, with more thoughtful processes resulting in judgments that last longer over time and better resist future attempts at change. Guided by an attitudinal approach to anchoring, four studies manipulated participants' level of cognitive load to produce relatively high versus low levels of thinking. These studies show that, although anchoring can occur under both high and low thought conditions, anchoring based on a higher level of thinking involves greater use of judgment-relevant background knowledge, persists longer over time, is more resistant to subsequent attempts at social influence, and is less likely to result from direct numeric priming.

Introduction

In the *standard numerical anchoring paradigm*, people receive a random, presumably uninformative starting point for a judgment, reject the anchoring value as being too high or too low (in a comparative question), and provide their perception of the true value (the absolute estimate). Despite rejecting the anchor by saying that the true answer is higher or lower, people's judgments are routinely higher following high rather than low anchors (i.e., the anchoring effect, Epley, 2004; Tversky & Kahneman, 1974). Using this standard paradigm, anchoring has influenced judgments as diverse as the price one is willing to pay for a bottle of wine (Ariely, Loewenstein, & Prelec, 2003), the year Einstein first visited the United States (Strack & Mussweiler, 1997), and the likelihood of nuclear war (Plous, 1989).

But which psychological process(es) account for anchoring? Currently, the dominant view of anchoring in the standard paradigm focuses on confirmatory hypothesis testing (Chapman & Johnson, 1994; Chapman & Johnson, 1999; Mussweiler & Strack, 1999). When people consider an externally provided anchor that might represent a plausible answer, they test the hypothesis that the true answer is equal to the anchor value. In doing so, they look for ways the answer might be similar to the anchor value. Anchor-consistent aspects of the target thus become "selectively accessible" and bias judgments (Strack & Mussweiler, 1997). The process of hypothesis testing and confirmatory search has been characterized as relatively effortful and elaborative. For example, Mussweiler and Strack (2001) noted that "larger anchoring effects occur under conditions which promote the extensive generation of anchor-consistent target knowledge" (p. 238), and they concluded that anchoring in the standard paradigm "appears to involve a relatively elaborate process of testing the hypothesis that the target quantity may be similar to the comparison standard" (p. 252). The purpose of the current paper is to examine the implications of a more general, attitudinal approach to conceptualizing anchoring effects. As explained further below, an attitudinal approach to anchoring treats anchors as serving in "multiple roles" (i.e., sometimes serving as a simple cue to influence judgments rather directly and sometimes serving to bias effortful processing, similar to selective accessibility processes). Thus, the attitudinal approach incorporates both relatively thoughtful and non-thoughtful processes to account for the effects of standard numerical anchors. These different processes and the different circumstances in which they occur are important because according to contemporary attitude theory, judgments produced by relatively thoughtful processes are more consequential than judgments produced by relatively non-thoughtful processes.

* Corresponding author.
E-mail address: wegener@psych.purdue.edu (D.T. Wegener).

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An attitudinal approach: Multiple roles for numerical anchors

In theories of attitude change such as the elaboration likelihood model (Petty & Cacioppo, 1986) and heuristic–systematic model (Chaiken, Liberman, & Eagly, 1989), persuasion factors, such as source characteristics or a message recipient's mood, can take on multiple roles (see Petty & Wegener, 1998; Petty & Wegener, 1999, for reviews). That is, persuasion factors can influence attitudes in relatively non-thoughtful (peripheral or heuristic) ways or in relatively thoughtful (central or systematic) ways. For example, a positive mood can render attitudes in response to a message more favorable in a direct way when people are not thinking much (e.g., by more association or use of a mood heuristic) but by biasing the thoughts that come to mind when people are engaged in much thinking (Petty, Schumann, Richman, & Strathman, 1993; see Chaiken & Maheswaran, 1994, for a similar finding with respect to source credibility). Similarly, an attitudinal approach to anchoring suggests that numerical anchors should be capable of taking on multiple roles. Anchors should be able to influence judgments across different levels of elaboration (thinking) about the judgment of interest (Wegener, Petty, Detweiler-Bedell, & Jarvis, 2001). In some cases, effects of numerical anchors on judgment may result from relatively thoughtful, high-elaboration processes (cf., Mussweiler & Strack, 2001). However, in other cases, effects of numerical anchors on judgment may result from relatively non-thoughtful, low-elaboration processes (cf., Kahneman & Knetsch, 1993).

High-elaboration anchoring

Theories of attitude change have long characterized people as assessing the merits of a persuasive claim by comparing the claim with their existing knowledge and beliefs (see Hovland, Janis, & Kelley, 1953; McGuire, 1985). In other words, people *elaborate* on a claim by comparing it with their existing knowledge and by using that knowledge to interpret related information and determine what a reasonable perception of the object might be (Petty & Cacioppo, 1986). As people consider a persuasive claim, their reactions can have many dimensions, including viewing the claim as relatively acceptable or unacceptable, correct or incorrect, unbiased or biased (e.g., Petty, Ostrom, & Brock, 1981; Sherif & Hovland, 1961). High levels of elaboration or systematic processing are most likely to occur when the person is both motivated and able to put cognitive effort into assessing the qualities of the object of interest (Chaiken et al., 1989; Petty & Cacioppo, 1986).

Elaboration can also occur when people generate a persuasive message themselves (e.g., Janis & King, 1954) or simply think about the attitude object (e.g., Tesser, 1978). Thus, it seems quite reasonable for elaboration to also occur when thinking about a target after receiving a numerical anchor (cf., Mussweiler & Strack, 2001). Some high-elaboration processes can also be described as syllogistic or probabilistic reasoning (e.g., Kruglanski & Thompson, 1999; Petty & Wegener, 1998; Wegener & Carlston, 2005). In this sense, the elaboration described in theories of attitude change seems very similar to the process of hypothesis testing that forms the core of current anchoring theories (e.g., Chapman & Johnson, 1994; Chapman & Johnson, 1999; Mussweiler & Strack, 1999). In the attitudes literature, these effects would be referred to as *biased processing* effects of anchors on judgments (see Petty & Wegener, 1999). That is, just as a positive mood or a credible source can bias the thoughts that come to mind when people are motivated and able to engage in thought, so too can a numeric anchor.

Low-elaboration anchoring

Although elaboration (in theories of attitude change) and the notions of hypothesis testing and selective accessibility (in theories of anchoring) share some similarities, an attitudinal approach to the standard anchoring paradigm differs from prominent anchoring theories in important ways. Chief among these differences is that an attitudinal approach suggests that people are not always elaborative in assessing the merits of a claim. When people lack motivation or ability, changes in attitudes can result from less effortful use of *heuristics* or other *cues* to determine judgments (Chaiken et al., 1989; Petty & Cacioppo, 1986). For example, people might accept a claim, regardless of how the claim is supported, if they are in a good mood or if the person making the claim is an expert or is attractive (see Petty, Cacioppo, & Goldman, 1981; Petty, Cacioppo, & Schumann, 1983; Petty & Wegener, 1998; Petty et al., 1993, for discussion of these potential cue effects).

Similarly, we believe that numerical anchors can serve as judgment cues when motivation or ability to elaborate is lacking. A number of potential non-thoughtful processes might contribute to low-effort anchoring effects. For example, numerical anchors might directly prime the number, which is then used to arrive at an answer (e.g., Kahneman & Knetsch, 1993; Wilson, Houston, Etling, & Brekke, 1996; see also Wong & Kwong, 2000) or might prime a "magnitude" or general sense of an answer being relatively large or small (Oppenheimer, LeBoeuf, & Brewer, 2008). When the comparative and absolute questions refer to the same target (as in the standard paradigm), it could also be that participants lacking ability or motivation to think are more likely to treat the anchor as a "hint" to a reasonable judgment (Schwarz, 1994) without taking into account that the anchors were supposed to be randomly generated (as the anchors are typically described in the standard paradigm). The incorporation of non-thoughtful processes by which anchoring can occur differs from prominent anchoring theories that propose relatively elaborative confirmatory search/selective accessibility as the sole process responsible for anchoring in the standard paradigm (with alternative processes, such as serial adjustment or numeric priming only influencing judgments outside the standard paradigm, see Epley, 2004, p. 246; Mussweiler & Strack, 2001, pp. 241, 252).

Consequences of anchored estimates

Attitude theories predict that attitudes and judgments resulting from differing amounts of target-relevant elaboration will have different consequences (Petty & Cacioppo, 1986). That is, when a variable (e.g., mood) induces attitude change by a relatively thoughtful mechanism (e.g., biased processing), the new attitude is expected to persist longer over time, better resist future attempts at change, and provide stronger guides to future thoughts and behaviors when compared to situations in which the same variable produces the same extent of change, but by a less thoughtful mechanism (e.g., a mood heuristic) (see Petty, Haugtvedt, & Smith, 1995; Petty & Wegener, 1998). These differential consequences could occur for a number of associated reasons. For example, higher levels of elaboration could be associated with cognitive changes, such as increased accessibility of the attitude or judgment (Fazio, 2001), increased integration with relevant knowledge (Petty et al., 1995), or increased structural consistency of attitude-relevant knowledge (e.g., Chaiken, Pomerantz, & Giner-Sorolla, 1995). Higher levels of elaboration could also be associated with metacognitions, such as higher levels of confidence that the attitude or judgment is correct or that it reflects what the person really believes (e.g., Barden & Petty, in press; Chaiken et al., 1989; Petrocelli, Tormala, & Rucker, 2007; Tormala & Petty, 2002).

Thus, the multiple roles idea from attitude theories suggests not only that there could be relatively thoughtful and non-thoughtful versions of anchoring in the standard paradigm (rather than only elaborative selective accessibility), but also that relatively thoughtful versions of anchoring should have more lasting effects than non-thoughtful anchoring. Observing these differential consequences would lend powerful support to the attitudinal approach because previous anchoring theories have not specified moderators of the *consequences* of anchored assessments in the standard anchoring paradigm.[1]

Overview of the current research

The current research addressed three goals. First, we aimed to demonstrate, for the first time, that thoughtful and non-thoughtful versions of anchoring can occur within the standard anchoring paradigm, where comparative and absolute questions refer to the same target. Therefore, Experiment 1 tested the prediction that anchoring would occur across levels of cognitive load even though relevant background knowledge would influence judgments to a greater extent when cognitive load was low rather than high. Second, we sought to provide evidence that anchored estimates have more lasting impact when they are based on relatively high rather than low levels of elaboration (thinking). To test this idea, Experiment 2 examined whether anchored judgments last longer when formed under conditions of low rather than high cognitive load (i.e., high rather than low thinking). Similarly, Experiment 3 tested whether anchored judgments better resist social influence when formed under conditions of low rather than high cognitive load. Finally, we examined whether numeric priming is one relatively non-thoughtful process that is more likely to create anchoring effects when ability to think about target judgments is relatively low rather than high. Such results would provide strong evidence for the utility of our attitudinal view of numerical anchoring.

Experiment 1

In Experiment 1, we provided research participants with background knowledge that could be used in formulating estimates of target values in a later anchoring activity. Both attitude theorists (e.g., Petty & Cacioppo, 1986) and anchoring theorists (e.g., Mussweiler & Strack, 2000, 2001) regard effortful thinking as involving the consideration and use of background knowledge. Therefore, relative impact of background knowledge on anchored judgments seemed to be an appropriate way to assess the level of effortful, elaborative thinking that takes place under different levels of cognitive load.

For each participant, background knowledge about some targets suggested that the real values might be low, whereas knowledge about other targets suggested that the real values might be high. In the later anchoring activity, some participants received high anchors for target items, whereas other participants received low anchors for the same targets. Therefore, for some items, background knowledge was directionally consistent with the anchor, but for other items, background knowledge was anchor-inconsistent.

When cognitive load is low (i.e., with high ability to think about the target estimate), we expected that participants would be influenced by both the anchor and the direction of background knowledge. These influences would reflect use of accessible knowledge to formulate their estimates (consistent with selective accessibility mechanisms). However, when cognitive load is high (with low ability to think about the target estimate), participants should be influenced by the anchors but should be less likely to actively search knowledge in memory and use it in formulating their estimates. Thus, any observed anchoring effect would be due to less effortful information processing than when cognitive load is low.

This combination of processes should result in two primary results. First, an anchor main effect would show that anchoring occurred, collapsing across levels of cognitive load. Equal anchoring across levels of cognitive load would be useful in later studies for testing the moderating effects of cognitive load on consequences of anchored estimates (otherwise, the long-term consequences of amount of processing would be confounded by initial differences in the magnitude of anchoring effects). Second, with high ability to think (low cognitive load), effects of anchors should be greatest when background knowledge is consistent rather than inconsistent with the anchor, but with low ability to think (high cognitive load), background knowledge should have little effect on estimates. This pattern would result in an Anchor $\times$ Cognitive Load $\times$ Background Knowledge interaction.

Method

Participants and design

Fifty-three undergraduates enrolled in introductory psychology classes participated in the 2 (Anchor: low, high) $\times$ 2 (Cognitive Load: low, high) $\times$ 2 (Background Knowledge: anchor-inconsistent, anchor-consistent) mixed design with consistency of background knowledge as a within-subjects factor.

Procedure

In all of the current experiments, participants were seated at a computer running MediaLab v2002 software (Jarvis, 2002). In Experiment 1, participants were told that the purpose of the study was to assess people's reading comprehension, and they were given eight one-paragraph passages about "little known facts" related to various topics. Four of the topics were relevant to a subsequent anchoring task, and the other four topics were unrelated filler. Information in the background knowledge paragraphs was only indirectly related to the topics in the later anchoring task. For example, in one paragraph, participants read about a number of aspects of life in space and astronaut qualifications. Some of this information was relevant to a later anchoring item about the age of Neil Armstrong when he walked on the moon. The background knowledge did not specifically address Neil Armstrong but provided information that could be used to infer an astronaut's likely age. Across conditions, background knowledge was varied to suggest relatively low or high estimates (e.g., that astronauts were often relatively young or old; see Appendix A for the Neil Armstrong paragraphs).

After reading the background knowledge paragraphs, participants engaged in an unrelated impression formation task involving hypothetical targets unrelated to the current study. Following the filler impression formation task, and consistent with the reading comprehension cover story, participants were given a series of multiple-choice questions assessing the content of what they had read in the initial background knowledge paragraphs. The multiple-choice questions avoided the aspects of the paragraph that would be most relevant for the anchoring task (e.g., the question about the space life paragraph—related to the age of Neil Armstrong—simply asked participants about a 1950s event; the Korean Conflict, launching of the Sputnik satellite, Elvis Presley's first album, or the invention of Super Glue).

Finally, participants engaged in a standard anchoring task. Participants were first asked a comparative question—whether the real numerical value was higher or lower than an anchor value described as randomly generated—and were then asked to provide an

[1] It is important to note that non-thoughtful effects of cues or heuristics can be just as large as elaboration-based persuasion effects For example, thoughtful elaboration of strong message arguments can lead to the same extent of attitude favorability as use of the mere number of arguments as a cue or a "more is better" heuristic (Petty & Cacioppo, 1984). Similarly, relatively non-thoughtful cue effects and more thoughtful (biased processing) effects of the same variable can create the same attitude ratings (see Chaiken & Maheswaran, 1994; Petty et al., 1993; Wegener, Clark, & Petty, 2006). Because of this, researchers can compare the lasting impact of attitudes based on relatively high or low elaboration while holding attitude extremity constant (Petty et al., 1995).

absolute estimate of the real value.[2] For the current studies, high and low anchors were those labeled by Wegener et al. (2001) as moderately high and moderately low, respectively. Four of the eight items related to the previous background knowledge paragraphs. These items were the age of George Washington when he died, the weight of Julius Caesar, the age of Ernest Hemingway when he wrote his first successful novel, and the age of Neil Armstrong when he walked on the moon. The four filler items appeared first, two with high anchors and two with low anchors (in either a LHLH order or a HLHL order). After the filler items, participants completed the four target items (all paired with either high or low anchors). Following the anchoring task, participants were debriefed and given class credit for participating.

Independent variables

Cognitive load. Prior to the anchoring task, half of the participants were told that one purpose of the study was to examine how people are able to engage in multiple tasks at once (high cognitive load). While they were providing answers to some questions, they would hear a series of letters in their headphones and would have to report how many of those letters were vowels (for similar manipulations, see Martin, Seta, & Crelia, 1990; Wegener et al., 2006). Letters were spoken every 1.5 s, and participants were given an opportunity following each anchoring item to report the number of vowels that they had heard since their last report. The other half of the participants did not complete this secondary task (low cognitive load).

Anchor. For the four critical targets, half of the participants received high anchors (e.g., 48 years old for the age of Neil Armstrong when he walked on the moon), and the other half received low anchors (e.g., 23 years old for Neil Armstrong). The targets appeared in the same order for all participants.

Background knowledge. Participants received background knowledge that was consistent or inconsistent with the direction of the subsequent anchor. For participants who received high anchors, two of the background knowledge paragraphs also suggested that the answer was high (anchor-consistent knowledge), whereas the other two paragraphs suggested that their respective answers were low (anchor-inconsistent knowledge). When participants received low anchors, the two background knowledge paragraphs suggesting a low answer were anchor-consistent, and the two paragraphs suggesting a high answer were anchor-inconsistent.

Dependent measures

Because the metrics for the estimates varied to a large extent across questions (i.e., ages, weights), responses were standardized separately for each of the four targets (across participants and all conditions). To minimize the disproportionate impact of outliers on the standard scores, we used an outlier procedure developed by Tukey (1977) before calculating the standard scores. For each item, the difference between the 25th and 75th percentile (i.e., the inter-quartile range) was multiplied by 1.5. This value was subtracted from the 25th percentile and added to the 75th percentile, resulting in what Tukey referred to as the "inner fence" of the distribution. Values falling outside the inner fence are expected to occur with a 1 in 300 probability, and thus could be considered outliers.

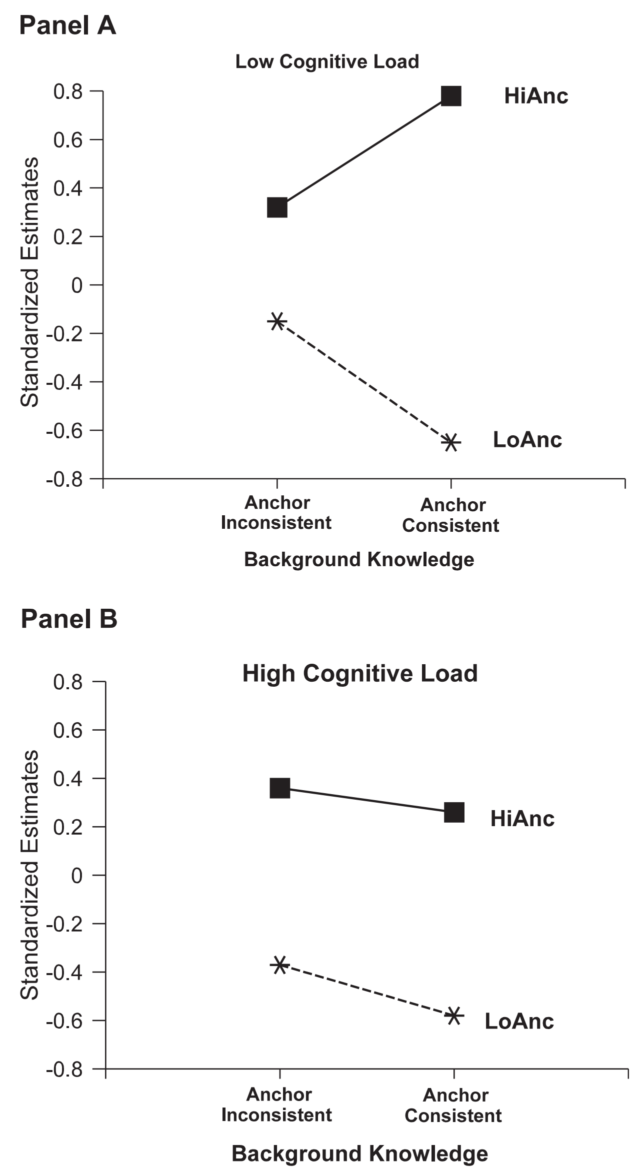

Fig. 1. Differential impact of background knowledge on anchored judgments (Experiment 1): standardized estimates as a function of anchor and background knowledge when cognitive load was relatively low (A) or high (B). LoAnc = low anchor. HiAnc = high anchor.

To be relatively conservative, rather than discarding these extreme values, we "fenced" them, such that values falling below the lower fence and falling above the upper fence were changed to the value equivalent to the nearest fence (for similar procedures, see Greenwald, McGhee, & Schwartz, 1998; Wegener et al., 2001). Only seven responses (out of 212 total responses) were fenced.[3] After fencing, judgments for each item were standardized to a mean of 0 and a standard deviation of 1. Standardized responses to the two items for which knowledge was anchor-consistent were averaged, as were the responses to the two items for which knowledge was anchor-inconsistent.

[2] Consistent with past research, we told participants that anchors were randomly generated (cf., Ariely et al., 2003; Mussweiler & Strack, 1999; Mussweiler & Strack, 2001). In research comparing anchors perceived as informative versus uninformative, the anchoring effect is found regardless of whether anchors are perceived as informative (e.g., Chapman & Johnson, 1999; see also Wegener et al., 2001).

[3] For all four studies, the same results are obtained if the outlying values are discarded rather than being fenced. For Experiments 2 and 3, the same results are obtained regardless of whether outliers are fenced across both measurement occasions or separately for each occasion.

Results

The averaged standard scores were analyzed using a 2 (Anchor) × 2 (Cognitive Load) × 2 (Background Knowledge) mixed analysis of variance (ANOVA), with background knowledge as a repeated factor. There was a main effect for Anchor, $F(1, 49) = 25.4$, $p < .001$, $r = .58$, such that participants receiving a high anchor gave higher estimates ($M = .43$) than those receiving a low anchor ($M = -.44$). Of note, this overall effect of anchor was equally strong, regardless of the level of cognitive load (Anchor × Load, $F < 1$; see Mussweiler & Strack, 1999, for similar effects using time pressure during the comparative question).

Consistent with use of background knowledge when formulating judgments, the effect of anchor was moderated by the consistency of knowledge [Anchor × Background Knowledge, $F(1, 49) = 13.83$, $p < .001$, $r = .47$]. Anchor-consistent background knowledge produced greater anchoring [*M*s = .52 and −.61, for high and low anchors, respectively, $F(1, 49) = 36.97$, $p < .001$, $r = .66$] than anchor-inconsistent background knowledge [*M*s = .34 and −.26, for high and low anchors, respectively, $F(1, 49) = 10.42$, $p < .001$, $r = .42$]. However, consistent with this use of background knowledge reflecting effortful processing, this effect of background knowledge primarily occurred when cognitive load was low [Anchor × Cognitive Load × Background Knowledge, $F(1, 49) = 8.68$, $p < .005$, $r = .39$, see Fig. 1].

When cognitive load was low, anchoring effects were larger when background knowledge was anchor-consistent [*M*s = .78 and −.65, for high and low anchors, respectively, $F(1, 24) = 23.56$, $p < .001$, $r = .7$] rather than inconsistent [*M*s = .32 and −.15, for high and low anchors, respectively, $F(1, 24) = 3.38$, $p < .08$, $r = .04$], Anchor × Background Knowledge, $F(1, 24) = 16.99$, $p < .001$, $r = .64$, see Panel A of Fig. 1. When cognitive load was high, however, anchoring effects were no stronger when background knowledge was anchor-consistent rather than inconsistent, Anchor × Background Knowledge, $F < 1$, see Panel B of Fig. 1. The simple effect of anchor was significant both when background knowledge was anchor-consistent [*M*s = .26 and −.58, for high and low anchors, respectively, $F(1, 25) = 13.12$, $p < .001$, $r = .38$] and when background knowledge was anchor-inconsistent [*M*s = .36 and −.37, for high and low anchors, respectively, $F(1, 25) = 7.38$, $p < .013$, $r = .48$]. The pattern of results suggests that participants were thinking more deeply and using background knowledge to a greater extent when cognitive load was low rather than high. Despite this, the impact of the anchor was equally strong under high and low load conditions.

Discussion

The results from Experiment 1 suggest that numerical anchors can be used in relatively thoughtful or non-thoughtful ways. That is, numerical anchoring can reflect *biased processing* of target-related background knowledge (i.e., biased in an anchor-consistent direction; cf., Mussweiler & Strack, 2001) when ability to think during the anchoring task is high (i.e., with low cognitive load). On the other hand, numerical anchoring can also reflect use of the anchor as a simple *cue* to judgment (i.e., with minimal use of target-related knowledge) when ability to think during the anchoring task is low (i.e., with high cognitive load). Therefore, similar to previous research in attitudes and social cognition, numerical anchors can serve in multiple roles to produce the same judgments with different amounts of thought (cf., Petty & Cacioppo, 1986; Petty & Wegener, 1998; Petty & Wegener, 1999).

Obtaining equal anchoring effects across different levels of cognitive load establishes the conditions specified by attitude theorists as needed to adequately test consequences of judgments (e.g., persistence over time, resistance to change, see Petty et al., 1995; Wegener et al., 2006). That is, though never demonstrated previously, it should be quite possible to create anchoring effects of equal magnitude that nonetheless have different consequences depending on the person's ability to process information when initially forming the judgments.[4]

Experiments 2 and 3 examined the persistence of anchored estimates over time and their differential resistance to subsequent social influence. Past research has shown that judgment effects of anchors can occur even when the judgment occurs a week after the anchor (Mussweiler, 2001) and that anchored responses can resist later change (Ariely et al., 2003; cf., Mussweiler, Strack, & Pfeiffer, 2001). However, there have never been any examinations of *moderators* of the persistence of anchored judgments or of their resistance to change. Thus, an attitudinal approach to anchoring generates predictions that would advance the anchoring literature in important ways.

Experiment 2

Attitudes based on high levels of thinking last longer than attitudes based on lower levels of thinking even when the initial attitudes are the same in both situations (see Petty et al., 1995; Wegener, Petty, Smoak, & Fabrigar, 2004). Experiment 2 was designed to directly compare the persistence of thoughtful versus non-thoughtful anchoring effects that are initially of the same magnitude. If anchored judgments persist longer when they are based on relatively thoughtful rather than non-thoughtful processes, this pattern would support the attitudinal approach to anchoring and would result in an Anchor × Cognitive Load × Time interaction.

Method

Participants and design

One hundred and thirty-seven undergraduates enrolled in introductory psychology classes participated in both sessions of the 2 (Anchor: low, high) × 2 (Cognitive Load: low, high) × 2 (Time: immediate, one-week delay) within-participants design.

Procedure

In session 1, groups of 2 to 7 participants engaged in the same type of standard anchoring task as in Experiment 1 (i.e., a comparative question followed by an absolute estimate). Participants encountered all eight targets used by Wegener et al. (2001; i.e., the record high temperature for a day in Seattle, Washington, the average starting annual salary of college graduates in the United States, the age of Amelia Earhart when she disappeared attempting to pilot a plane around the world, and the length of time an average American person spends eating an evening dinner at home, plus the four targets from Experiment 1). Each item at Time 1 contributed to the 2 (Anchor: low, high) × 2 (Cognitive Load: low, high) within-participants design, with two items falling within each of the four cells. Targets appeared in the same order for all participants.

[4] Equal amounts of anchoring occurred for both the critical targets (where background knowledge was manipulated) and for the filler items (with no background knowledge manipulation). For filler items, high anchors produced higher judgments ($M = .22$) than low anchors ($M = -.32$), $F(1, 49) = 15.01$, $p < .001$, and this occurred equally across levels of cognitive load, Anchor × Load, $F < 1$. Tests of persistence and resistance called for equal anchoring effects across levels of cognitive load, but effects of background knowledge meant collapsing across cells that produced substantially different amounts of anchoring (when cognitive load was low). Therefore, instead of manipulating background knowledge in the subsequent studies, we treated the targets the same as the filler items in Experiment 1 (i.e., using the same manipulation of cognitive load but no manipulations of background knowledge).

The anchor and cognitive load manipulations were counterbalanced across questions. Participants either completed the same secondary listening and tracking task as in Experiment 1 during the first four anchoring items or during the last four anchoring items. Within each set of four items, some participants received two high-anchor items followed by two low-anchor items, whereas the remaining participants received two low-anchor items followed by two high-anchor items. Therefore, the cells of the 2 (Anchor) × 2 (Cognitive Load) design were distributed across the eight judgments in one of four orders. After completing the anchoring task, participants completed and were debriefed on an unrelated study and were given class credit for research participation.

One week later, participants returned to the lab. They began the session by simply being asked to make the same estimates as in session 1 (in the same order), but with no anchors present. After completing materials unrelated to the current experiment, participants were fully debriefed regarding both sessions of the study and were given class research credit.

Independent variables

Cognitive load. Prior to the anchoring task, participants were told that one of the purposes of the study was to examine how people are able to engage in multiple tasks at once. Half of the participants completed the secondary task (high cognitive load) during the first four anchoring items but not during the last four items (low cognitive load). The other half of the participants completed the secondary task during the last four anchoring items, not the first four.

Anchor. Half of the participants alternated between two high-anchor items (e.g., 48 years old for the age of Neil Armstrong when he walked on the moon) and two low-anchor items (e.g., 23 years old; i.e., a HHLLHHLL order). The remaining participants alternated between pairs of low-anchor items and high-anchor items (i.e., LLHHLLHH).

Dependent measures

The dependent measures were the absolute estimates provided for each item. Once again, because the metrics varied greatly across items, standard scores were created for each item (across all people and both sessions) after outlying responses had been identified using the Tukey (1977) procedure. Eighteen responses (out of a total of 2192 responses) were "fenced" prior to calculation of standard scores. After standardization, participants' two responses for each within-subject condition were averaged.

Results

The average standard scores were analyzed using a 2 (Anchor) × 2 (Cognitive Load) × 2 (Time) repeated-measures ANOVA. Results confirmed our predictions. There was an overall main effect for Anchor, $F(1, 136) = 88.33$, $p < .001$, $r = .63$, with high anchors resulting in higher estimates than low anchors (Ms = .29 vs −.30, respectively). There was also a significant Anchor × Time interaction, $F(1, 136) = 46.16$, $p < .001$, $r = .50$. Anchoring effects were strongest on immediate judgments and dissipated over the following week. The simple effect of anchor was stronger for immediate judgments [high- and low-anchor Ms = .40 and −.40, respectively, $F(1, 136) = 109.78$, $p < .001$, $r = .67$] than for delayed judgments [high- and low-anchor Ms = .19 and −.20, respectively, $F(1, 136) = 39.47$, $p < .001$, $r = .47$].

Most importantly, these effects were qualified by the predicted Anchor × Cognitive Load × Time interaction, $F(1, 136) = 14.68$, $p < .001$, $r = .31$ (see Fig. 2). On immediate judgments, there was a significant simple effect of Anchor, $F(1, 136) = 105.53$, $p < .001$, $r = .66$, with high anchors resulting in higher estimates ($M = .40$)

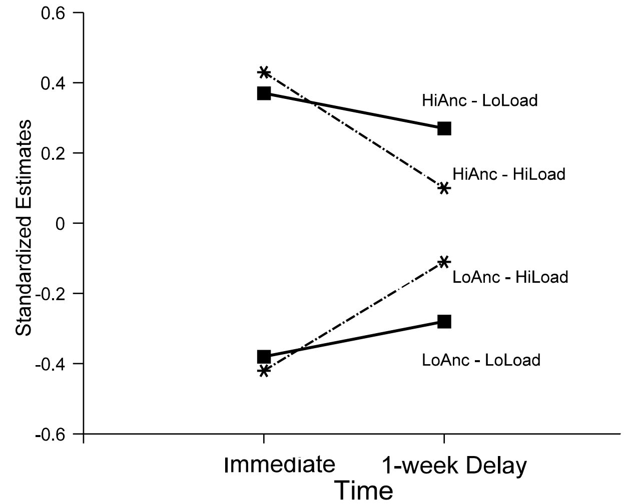

Fig. 2. Differential persistence of anchored judgments over time (Experiment 2): standardized estimates as a function of anchor, cognitive load during initial anchoring, and time. LoAnc = low anchor. HiAnc = high anchor. LoLoad = low cognitive load. HiLoad = high cognitive load.

than low anchors ($M = -.40$). Neither the main effect of Load nor the Anchor × Load interaction was significant (Fs < 1.23; similar to the filler items in Experiment 1). Thus, there was no difference in initial anchoring as a function of the cognitive load manipulation. However, one week later, the overall anchoring effect was qualified by the predicted Anchor × Load interaction, $F(1, 136) = 10.19$, $p < .002$, $r = .26$. Later judgments were significantly more influenced by anchors when initial anchored judgments were made while under a low level of cognitive load [Ms = .27 and −.28 for high and low anchors, respectively, $F(1, 136) = 55.58$, $p < .001$, $r = .54$] rather than a high level of cognitive load [Ms = .10 and −.11 for high and low anchors, respectively, $F(1, 136) = 6.1$, $p < .014$, $r = .2$].

Discussion

Experiment 2 provided the first evidence of differential persistence of anchored judgments when they were initially made under conditions that either allowed for thoughtful consideration of the target judgment or constrained ability for elaborative thinking. Anchored perceptions lasted longer over time if they were formulated in thoughtful rather than non-thoughtful ways (even though the thoughtful and non-thoughtful forms of anchoring resulted in initial judgments that looked the same). This result supports the attitudinal view of anchoring.

Experiment 3

Attitudes based on higher levels of elaboration are also more likely to resist subsequent (even immediate) attempts at change (see Petty et al., 1995; Wegener et al., 2004). Therefore, we expected anchored estimates to better resist attempts at social influence if the anchored estimates were formed on the basis of high- rather than low-elaboration processes.

Method

Participants and design

Ninety-five undergraduates enrolled in introductory psychology classes participated in the 2 (Anchor: low, high) × 2 (Cognitive Load: low, high) × 2 (Judgment: initial, post-attack) within-participants design.

Procedure

All participants were given the same cover story, instructions for the secondary task, targets, and anchors as in the anchoring task from Experiment 2. Half of the participants completed the secondary task during the first four items, and the other half completed the secondary task during the last four items. Across the eight items, participants encountered two items in each combination of cognitive load and anchor (in one of four completely counterbalanced orders). After the initial anchoring task, participants completed the same filler task used in Experiment 2. Participants were then confronted with an attack on their initial anchored estimates. They were told that previous participants had provided estimates for the same items that were quite different from their own initial estimates. Specifically, participants were told that in prior studies of this type, ten percent of participants provided an estimate that was either substantially higher (in low anchor conditions) or lower (in high anchor conditions) than the estimate the participants had provided.

For example, for the age of Ernest Hemingway when he wrote his first successful novel, participants' average initial anchored responses were 23 years when the anchor was low and 43 years when the anchor was high. When the initial anchor was low, the attack stated that 10% of previous participants had said that Hemingway was 50 years old or older. When the initial anchor was high, the attack stated that 10% of previous participants had said that Hemingway was 16 years old or younger. For each item, the high and low values of the attacks corresponded to the 90th and 10th percentiles of unanchored responses in a pretest. After the attack, participants were given an opportunity to provide another estimate of the target value.

Dependent measures

Extreme initial and post-attack estimates were identified using the Tukey (1977) procedure. Fourteen responses (out of 1520 total) were "fenced." Responses were then standardized separately for each of the eight items across all participants and across both measurement occasions. After standardization, participants' two responses for each condition were averaged to provide a single response for that condition.

Results

The average standard scores were analyzed using a 2 (Anchor) × 2 (Cognitive Load) × 2 (Judgment) within-subjects ANOVA. Similar to Experiment 2, differences in resistance to change when initial anchored responses were formed with high rather than low ability to think (an Anchor × Cognitive Load × Judgment interaction) would support the attitudinal approach.

Again, results supported our predictions. There was a main effect for Anchor, $F(1, 94) = 105.33$, $p < .001$, $r = .73$, with high anchors ($M = .33$) leading to higher estimates than low anchors ($Ms = -.32$). Though not of theoretical interest, there was also a main effect for judgment, $F(1, 94) = 4.88$, $p = .03$, $r = .22$, with higher initial ($M = .04$) than post-attack estimates ($M = -.03$). There was also an Anchor × Judgment interaction, $F(1, 94) = 129.38$, $p < .001$, $r = .76$. Greater anchoring occurred initially [Ms for high and low anchors = .57 and −.50, respectively, $F(1, 94) = 237.6$, $p < .001$, $r = .84$] than after the attack [Ms for high and low anchors = .08 and −.14, respectively, $F(1, 94) = 9.46$, $p < .003$, $r = .3$].

Most importantly, these effects were qualified by the predicted Anchor × Cognitive Load × Judgment interaction, $F(1, 94) = 3.95$, $p < .05$, $r = .20$ (see Fig. 3). For initial judgments there was only a simple main effect for Anchor, $F(1, 94) = 221.29$, $p < .001$, $r = .84$, with higher estimates following high ($M = .57$) than low ($M = -.50$) anchors. No other effects were significant ($Fs < 1$). For post-attack judgments, there was a smaller but significant simple main effect for Anchor, $F(1, 94) = 9.37$, $p < .003$, $r = .30$, with higher estimates following high ($M = .08$) than low ($M = -.14$) anchors. However, the post-attack anchor effect was qualified by the predicted Anchor × Cognitive Load interaction, $F(1, 94) = 6.73$, $p < .01$, $r = .26$. Anchoring remained stronger (resisted the attack to a greater extent) if anchored judgments initially occurred with low [Ms for high and low anchors = .18 and −.21, respectively, $F(1, 94) = 19.83$, $p < .001$, $r = .42$] rather than high cognitive load [Ms for high and low anchors = −.01 and −.07, respectively, $F(1, 94) = .45$, $p = .5$, $r = .08$]. Thus, participants were more susceptible to a subsequent attack when cognitive load was high rather than low during the initial anchoring task. This was true even though the initial anchoring effect was equally large across levels of cognitive load.

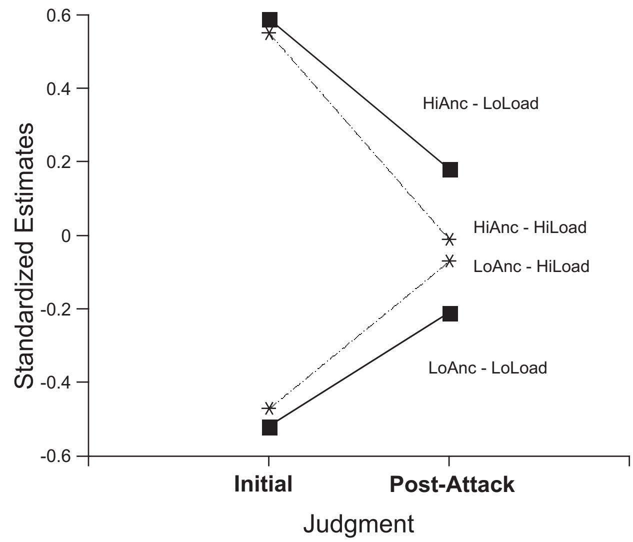

Fig. 3. Differential resistance of anchored judgments to attack (Experiment 3): Standardized estimates as a function of anchor, cognitive load during initial anchoring, and judgment. LoAnc = low anchor. HiAnc = high anchor. LoLoad = low cognitive load. HiLoad = high cognitive load.

Discussion

The results of Experiment 3 are consistent with thoughtful anchoring being more resistant to future attempts at change than equal amounts of initial anchoring that were generated via less thoughtful mechanisms. This pattern is consistent with previous evidence of multiple roles in which thoughtful effects of stereotypes on judgments were more resistant to social influence than non-thoughtful effects of stereotypes on judgments (Wegener et al., 2006). Given the very short delay between the formation of the judgment and the attack on it, both thoughtfully formed and non-thoughtfully formed judgments would presumably have shown persistence without the attack. Nevertheless, the non-thoughtfully formed judgment showed its relative weakness by being more susceptible to an attack. This is important because, in many settings, the lasting impact of one's perceptions may be determined by the extent to which current perceptions and beliefs are capable of remaining steady in the face of challenges.

Comparing persistence and resistance

Readers might have observed that the same relatively high level of cognitive load completely removed the initial effect of anchors after the social influence "attack" in Experiment 3 but left some persistence of anchoring after the one-week delay in Experiment 2. There may be some practical as well as theoretical considerations that can account for this difference. On the practical side, although the cognitive load manipulation was the same across studies, there is no a priori way to equate the psychological impact of the length of delay used in testing persistence in Experiment 2 with the power of the attack used in testing resistance in Experiment 3. Thus, it could well be that a longer delay would have removed all persistence of high-load anchoring (even if substantial anchoring remained for the low-load conditions). Similarly, a weaker attack in the resistance paradigm (either with a smaller consensus or with less extreme claims) might have left some effects of initial anchors for people in high-load conditions (even if effects of initial anchors remained stronger for people in low-load conditions). In each case, however, the key for our elaboration-based predictions is that the level of load produced relative differences in the amount of persistence or amount of resistance (each of which occurred in our experiments).

There is also a relevant theoretical point to be made that has received little attention in previous research. As Wegener, Downing, Krosnick, and Petty (1995) noted in the persuasion domain, it could well be that there are important process differences across persistence and resistance settings, and these process differences may also implicate different strength-related properties of attitudes (or, in the current case, anchored perceptions). Wegener et al. (1995) used a comparison between elaboration and accessibility to illustrate the broader point. They noted that accessibility can come from elaboration, but it can also come from less thoughtful sources, such as repeated expression (see Fazio, 1995). However, there may be differences between accessibility that comes from low- versus high-elaboration sources, and the impact of these differences may depend on whether the consequence of interest is persistence or resistance. For example, accessibility per se (regardless of whether it comes from elaboration or from repeated expression) may be enough to create persistence over time when the person's view is not challenged. In contrast, resistance may often benefit from the resources that elaboration may add to the person's arsenal for arguing against the opposing position.

Thus, in the anchoring setting, it could be that accessibility of the anchored perception itself would be enough to help at least some people reproduce that judgment (or something similar to it) after a delay. The length of delay would still matter, but just as accessibility of constructs can influence delayed judgments (see Mussweiler, 2001; Srull & Wyer, 1980), so might accessibility of anchored judgments (regardless of the source of the initial accessibility). On the other hand, when confronting the fact that others disagreed with one's assessments, mere accessibility (without elaboration) might not have equipped the person to resist the "attack" very well. We welcome future anchoring research (and future research in persuasion) that more directly addresses which strength-related properties are necessary and sufficient when dealing with different potential consequences.

Potential mechanism for non-thoughtful anchoring

Experiments 1–3 provided direct evidence of relatively thoughtful versus non-thoughtful anchoring (in Experiment 1) and evidence of differential consequences of these different types of anchoring (in Experiments 2 & 3). However, the experiments did not provide specific evidence of any of the potential non-thoughtful processes that might have created the anchoring when cognitive load was high.

We believe that non-thoughtful anchoring can result from a variety of processes that do not require effortful consideration of background knowledge. For example, numeric priming has been discussed for some time as a possible mechanism for some anchoring effects (e.g., Kahneman & Knetsch, 1993; Wilson et al., 1996; see also Wong & Kwong, 2000). That is, an anchor might activate a number that remains in mind when the target estimate is formed. A common paradigm for demonstrating numeric priming is to ask the comparative question (with the anchor) about one object, but to ask for target estimates about a completely different object (e.g., Mussweiler & Strack, 2001; Wong & Kwong, 2000). When the comparative question and target estimate pertain to separate objects, the semantic knowledge activated by the comparative question is not applicable to the target estimate. Thus, according to the logic of Mussweiler and Strack (2001), semantic influences of the anchor are eliminated (or at least substantially reduced) and the alternative, numeric priming influences are left to influence judgments.

Numeric priming might especially influence judgments when ability to think about the judgment is low (and the numeric priming does not have to compete with knowledge people possess about the target, cf., Experiment 1). However, when people think carefully about the target estimate, they are likely to consider target-relevant knowledge (as in Experiment 1). Because this background knowledge would be equal across anchor conditions (to which people are randomly assigned), the judgment implications of the knowledge would often conflict with the primed number. Thus, when ability to think is high, it is not surprising to find minimal effects of the semantically-irrelevant numeric primes (as in Studies 1 and 2 of Mussweiler & Strack, 2001). Yet, when ability to think is relatively low and little judgment-relevant knowledge is considered, substantial influence of the primed number might occur.

In sum, increasing elaboration should decrease the impact of numeric priming on judgment and should increase the impact of target-relevant knowledge, but decreasing elaboration should increase the impact of numeric priming and decrease the impact of target-relevant knowledge. This would directly parallel the elaboration likelihood model hypotheses of increased impact of peripheral cues on attitudes and decreased impact of central merits as the amount of elaboration decreases (e.g., Petty & Cacioppo, 1986).

If numeric priming influences judgments more when cognitive load is high rather than low, this would be the first evidence of *moderation* of numeric priming effects by social perceivers' ability to elaborate during the judgment task. Such results would also suggest that numeric priming is one process that contributes to relatively non-thoughtful versions of anchoring.

Experiment 4

We provided research participants with the same eight targets and the same anchors (either high or low) used in the previous experiments. Similar to previous work on numeric priming, however, the anchors were presented in a comparative question that pertained to a different object. For example, participants were asked whether the age of the oldest person alive was higher or lower than 128/68 years. Afterwards, participants were asked to estimate the record high temperature for Seattle, Washington. Thus, although the target judgments were the same as in the previous experiments, the comparison question now asked about a judgment to a totally different object unrelated to the target judgment. We crossed this anchor manipulation with the same cognitive load manipulation used previously.

We expected that use of different objects in the comparative question and target estimates would decrease the semantic influence of the anchors when cognitive load was relatively low (because thinking about the comparative question fails to activate semantic knowledge related to the absolute judgment, see Mussweiler & Strack, 2001). However, high cognitive load (that decreases consideration of target-relevant knowledge) should allow numeric priming processes to influence judgments. This would result in an Anchor × Cognitive Load interaction.

Method

Participants and design

Ninety-eight undergraduates enrolled in introductory psychology classes participated in the 2 (Anchor: low, high) × 2 (Cognitive Load: low, high) mixed design with Anchor as a within-participants factor.

Procedure

Participants engaged in a similar anchoring paradigm using the same eight items as in previous experiments. Participants were first asked a comparative question—whether the real numerical value was higher or lower than an anchor value described as randomly generated—and were then asked to provide an estimate of a real target value. However, in this experiment, the comparative questions were about objects that were not at all related to the target estimates. On half of the items, anchors were high; on the other half, they were low. The anchors were counterbalanced across participants such that half of the participants received one ordering of high and low anchors (HLHLHLHL), but the other half received the counterbalanced order (LHLHLHLH). During the anchoring task, participants either encountered the same secondary task used in high-load conditions of the previous experiments or did not. Following the anchoring task, participants were debriefed and given class credit for participating.

Independent variables

The cognitive load and anchor manipulations were the same as those used previously.

Dependent measures

Outlying responses to each target were identified using the Tukey procedure and fenced prior to standardization. Only six responses (out of 784 total responses) were fenced. Averages of the standardized estimates within levels of cognitive load and anchor were the dependent measure of interest.

Results

The averaged standard scores were analyzed using a 2 (Anchor) × 2 (Cognitive Load) mixed design ANOVA. There was no overall main effect of anchor, $F(1, 96) = 1.36$, $p = .25$. However, as expected, there was an Anchor x Cognitive Load interaction, $F(1, 96) = 6.88$, $p = .01$, $r = .26$ (see Fig. 4). There was a significant anchoring effect (*Ms* = .06 and −.16, for high and low anchors, respectively), $F(1, 44) = 5.66$, $p = .022$, $r = .34$, when cognitive load was high. In contrast, there was no anchoring effect when cognitive load was low (*Ms* = −.03 and .05, for high and low anchors, respectively), $F(1, 52) = 1.35$, $p = .25$, $r = .16$.

Discussion

The results of Experiment 4 are consistent with numeric priming effects being stronger when ability to think carefully about the target judgment is decreased. These results might help to reconcile some seeming inconsistencies in the literature, as some researchers have produced robust numeric priming results (e.g., Wong & Kwong, 2000), whereas others have shown such effects to be rather weak (e.g., Brewer & Chapman, 2002; Mussweiler & Strack, 2001). In the current work, although participants were required to pay attention to the anchor in order to answer the comparative question, numeric priming effects were only evident when ability to think carefully about the absolute judgment was limited. Thus, perhaps part of the difference across past studies has related to the extent to which participants were fatigued or distracted by other features of the research setting as they completed the study.

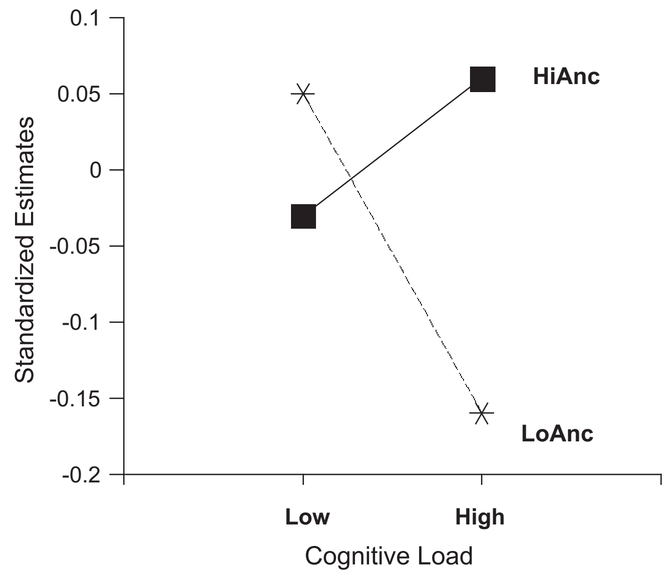

Fig. 4. Differential impact of numerical priming across levels of cognitive load (Experiment 4): Standardized estimates as a function of anchor and cognitive load. LoAnc = low anchor. HiAnc = high anchor.

Of greater relevance to the current theory, increasing effects of numeric priming as cognitive ability decreases is consistent with numeric priming being one relatively non-thoughtful mechanism through which anchoring might occur. Therefore, numeric priming may be responsible for at least part of the anchoring effects from Experiments 1–3 when cognitive load was high (i.e., when people did not use background knowledge and anchored estimates persisted less over time and resisted change less than when cognitive load was low).

Similar to attitude change, where many processes can influence attitudes in relatively non-thoughtful ways (see Petty & Wegener, 1998; Wegener & Carlston, 2005), there may be various non-thoughtful processes that contribute to anchoring effects. For example, in our experiments, high levels of cognitive load might also have kept participants from considering the fact that anchors were supposed to be randomly generated and, therefore, not informative regarding the true target values (cf., Schwarz, 1994). Simplified versions of adjustment (cf., Tversky & Kahneman, 1974; rather than the effortful version of adjustment discussed by Epley & Gilovich, 2001) or selective accessibility (cf., Mussweiler & Strack, 2001) might also exist that do not rely on the effortful use of background knowledge or do so to a reduced extent.

Regardless of which specific processes combine to create non-thoughtful anchoring, Experiment 4 demonstrates that at least one such process influences judgment to a greater extent when cognitive load is high rather than low. This is the opposite pattern to that observed in Experiment 1 for the use of background knowledge, because background knowledge influenced judgment more when cognitive load was low rather than high (consistent with anchoring theories that characterize confirmatory search and selective accessibility as effortful). Future research might profitably explore which additional non-thoughtful processes help to create anchoring effects. The need to do so is bolstered by evidence demonstrating that non-thoughtful and thoughtful anchoring effects differ in their consequences.

General discussion

When people are asked to make target estimates in the standard anchoring paradigm, they attempt to generate a correct answer. In so doing, they sometimes think about and use target-relevant knowledge. At other times, however, they might think less about target-relevant knowledge and instead provide their responses based on other input. We believe that these processes parallel in many ways the cognitive processes at work when people attempt to arrive at correct attitudes (Petty & Cacioppo, 1986; Petty & Wegener, 1998; Petty & Wegener, 1999; Wegener & Carlston, 2005; Wegener et al., 2001). Interestingly, the ideas generated from an attitudinal view of numerical anchoring provide a number of insights into the operation and lasting impact of numerical anchors. Beyond surface similarities between the standard anchoring paradigm and past research on formation and change of beliefs and attitudes (see Wegener et al., 2001), the current research demonstrates that there are process and consequence similarities between anchoring and attitude change.

When motivation and ability to think are relatively high during the standard anchoring paradigm, people consult target-relevant knowledge in memory and use this information when they form their judgments (Experiment 1). This use of background knowledge is very similar to "elaboration" (Petty & Cacioppo, 1986) or "systematic processing" (Chaiken et al., 1989) in the attitudes domain and to "confirmatory search" (Chapman & Johnson, 1994; Strack & Mussweiler, 1997) or "selective accessibility" in the anchoring domain (Mussweiler & Strack, 1999, 2001). Thus, one of the roles that numerical anchors can play is to bias processing of target-relevant information.[5]

But the multiple roles notion from contemporary attitude change theory also suggests that cue effects of anchors can occur when ability to think is low (and consideration of target-relevant knowledge is minimal, as in Experiment 1). Notably, this attitudinal perspective also holds that more thoughtful (biased processing) versions of anchoring should last longer and be more capable of resisting social influence than the less thoughtful (cue effect) versions of anchoring. Indeed, when research participants had high rather than low ability to think during the anchoring task, their anchored assessments lasted longer over time (Experiment 2) and immediately resisted social influence to a greater extent (Experiment 3). These results provide important support for the attitudinal perspective on anchoring because previous anchoring theories have not made predictions about moderators of the consequences of anchored estimates.

Experiment 4 provided initial evidence that at least one anchoring process previously discussed as relatively non-thoughtful (i.e., numeric priming) has greater impact when ability to think is relatively low (opposite of the impact of background knowledge on anchored judgments). Using a numeric priming paradigm that limits semantic influences of the anchors (cf., Mussweiler & Strack, 2001), we found that numeric priming created greater anchoring when cognitive load was relatively high rather than low. With high levels of load, respondents are less likely to search and use related knowledge in memory that might help them to formulate a reasonable estimate (as in Experiment 1). Instead, they may use the primed anchor values directly when formulating their answers. It also seems quite possible that the anchor numbers activate a more general sense of largeness or smallness that carries over to the target of the absolute estimate (i.e., magnitude priming, Oppenheimer et al., 2008). The fact that very few absolute estimates are identical to the anchor value is consistent with this possibility.

In Experiment 4, numeric (or magnitude) priming effects were relatively small. Thus, it may be that these priming effects combine with other relatively non-thoughtful processes to create low-effort (cue) effects of anchors in the standard anchoring paradigm. For example, when the comparative question and estimate refer to the same target, it could be that participants under high cognitive load are more likely to treat the anchor as a "hint" to a reasonable judgment (Schwarz, 1994) without taking into account that the anchors were supposedly random.

Taken together, the results of the current experiments are consistent with the idea that anchors can influence people's estimates by taking on multiple roles (Petty & Cacioppo, 1986; Petty & Wegener, 1998; Petty & Wegener, 1999; see Wegener et al., 2001). In the current context, the notion of multiple roles suggests that the same anchor can produce the same judgment via relatively thoughtful or non-thoughtful processes. Yet, consistent with an elaboration-based, attitudinal view of anchoring, the different levels of thinking across conditions opened the doors for differential consequences of the anchors. Past discussions of "shallow" versus "systematic" anchoring processes have predicted different sizes of initial anchoring effects and have described the processes as applicable to different anchoring paradigms (Mussweiler & Strack, 2001), which makes direct comparisons of consequences less meaningful (Petty et al., 1995). However, the concept of multiple roles for anchors suggests, and we found, that high and low levels of elaboration can create similar initial judgments in the standard anchoring paradigm that nonetheless differ in their consequences.

Future directions

In well-known anchoring studies, researchers have tested whether the effects of anchors can be removed by getting social perceivers to think more carefully about judgments (e.g., see Brewer, Chapman, Schwartz, & Bergus, 2007; Chapman & Johnson, 1999; Wilson et al., 1996). In many cases, incentives have failed to decrease anchoring. Yet, such manipulations may have successfully increased the amount of thinking that occurred during creation of the anchoring effect. If so, then the current approach and results suggest that these incentives might have created changes in the resulting *consequences* of the initial judgments, consequences that were not tested in the initial studies. In the current Experiments 2 and 3, if the study had ended after the initial judgments, it would have looked like the manipulation of cognitive load had no effect on anchoring. But the load manipulation did have important demonstrable effects on the persistence of anchored estimates over time and on resistance to change in the face of contrary social information. To the extent that amount of thinking can be influenced by both motivation and ability (see Petty & Wegener, 1998), it could be that incentive manipulations not only failed to remove anchoring effects in prior research, they might also have created anchoring effects that have greater lasting impact than the anchoring effects created in the absence of incentives. Such implications of the current approach await future anchoring studies.

We cannot claim a complete answer to the totality of processes that can produce anchoring effects in the standard paradigm. However, the current results suggest that the complete answer may be considerably more complex than previously suggested in the anchoring literature. Rather than relatively thoughtful, elaborative, selective accessibility mechanisms being the only explanation for anchoring effects in the standard paradigm, other less thoughtful mechanisms can operate. This includes (but is likely not limited to) numeric or magnitude priming. At this point, we would not discount the possibility that less thoughtful versions of selective

[5] We have treated descriptions of selective accessibility in anchoring as consistent with the concept of elaboration in attitude change. This does not mean, however, that we agree with everything Mussweiler and colleagues have said about selective accessibility effects. For example, they predict equal or larger effects of anchors on judgment as the anchors get more extreme (e.g., Mussweiler & Strack, 1999; Strack & Mussweiler, 1997). However, consistent with past attitude effects of message extremity, we have previously found curvilinear effects of anchor extremity (including smaller anchoring effects with implausibly extreme, rather than more moderate anchors, see Wegener et al., 2001).

accessibility, adjustment, or use of the anchor as a hint might also operate.

Incorporating multiple processes has not been a central part of previous theories of anchoring in the standard paradigm. We hope, however, that the current results and discussion prompt additional research investigating various possible processes underlying relatively thoughtful or non-thoughtful influences of numerical anchors on judgments.

Acknowledgements

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Appendix A. Example background knowledge paragraphs

A.1. Paragraph consistent with an old Neil Armstrong

A.1.1. Space

In the future, living for prolonged periods in space may become a reality. Current research on exercise in space has found that people who spend a significant amount of time in space lose a good proportion of bone mass from the lack of resistance due to gravity. Even so, the diet for astronauts hasn't changed much over the years. For example, dehydrated meat has been a staple for thirty years. Machines installed in spacecraft re-hydrate the food prior to consumption. Due to its novelty, however, eating food in this form can take some getting used to. Some astronauts have post bachelor's degrees in diverse fields such as engineering and aeronautics. Some also have decades of military experience and training, especially for the early space missions which were incredibly intense. As a result, some astronauts are nearing middle age by the time they are qualified to go into space. This has been the case since the beginning of the space program. Some astronauts in the late 1960s were pilots in the Korean "conflict" in the early 1950s, which helped them become familiar with the technical aspects of space flight. In addition to the rigorous training, a strict diet is required to keep the astronauts healthy. What has changed in the space program over the years has been the enrollment of female astronauts in the space program. Women have been increasingly involved over the years, yet it is still a male dominated profession. One reason for why the gender gap still exists is because there are too few women with math and science based degrees.

A.2. Paragraph consistent with a young Neil Armstrong

A.2.1. Space

In the future, living for prolonged periods in space may become a reality. Current research on exercise in space has found that people who spend a significant amount of time in space lose a good proportion of bone mass from the lack of resistance due to gravity. Even so, the diet for astronauts hasn't changed much over the years. For example, dehydrated meat has been a staple for thirty years. Machines installed in spacecraft re-hydrate the food prior to consumption. Due to its novelty, however, eating food in this form can take some getting used to. Some astronauts have military training, which helps them stay in good physical shape. It is ideal for astronauts to be young and in shape for the physical demands they have to meet. For example, having good reflexes and hand eye coordination is a must. Young "hot shot" pilots were recruited from the military to become the first astronauts. In addition, the "space race" between the U. S. and U.S.S.R. (after the Russians launched the first sputnik satellite in 1957) lent itself to an increased pace in training to be the first people in space. As a result, some astronauts were relatively young when they first went into space. What has changed in the space program over the years has been the enrollment of female astronauts in the space program. Women have been increasingly involved over the years, yet it is still a male dominated profession. One reason for why the gender gap still exists is because there are too few women with math and science based degrees.

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