

# Anchoring without scale distortion

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## Abstract

The scale distortion theory of anchoring argues that people are influenced by a previously considered numeric value, an anchor, because the anchor distorts the scale on which a subsequent judgment is made. The distortion of the scale due to the anchor is a momentary effect that would be overridden if the scale was distorted again, for example, by consideration of a different value on the same scale. In the present study, participants compared thirteen random anchors on the same scale to thirteen different objects. Subsequent numeric estimates of objects' attributes were influenced by the corresponding anchors even though the anchors were divided from the estimates by twelve questions pertaining to different values on the same scale. The numeric value considered immediately before the estimate did not have a considerable effect on the judgment. While the anchoring effect was robust, it cannot be easily explained by scale distortion. Other possible theories of the anchoring effect are compatible with the results.

Keywords: anchoring, scale distortion, judgment

## 1 Introduction

The anchoring effect — assimilation of a judgment toward a previously considered value — has been studied for almost half a century (Bahník et al., 2017; Furnham & Boo, 2011; Tversky & Kahneman, 1974). Yet, the mechanisms underlying anchoring are still debated. The recently proposed scale distortion theory of anchoring (Frederick & Mochon, 2012; Mochon & Frederick, 2013) argues that the anchoring effect occurs because perception of

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the scale on which a judgment is made is distorted by a previously considered value, the anchor. For example, when the anchor is small, higher values on the same scale seem larger in comparison. When a numerical estimate of a certain attribute is subsequently made on this scale, the estimated attribute is mapped to a lower value on the scale because this value seems larger due to the previous consideration of the anchor value.

The anchoring effect has been often studied using the *standard anchoring paradigm*, in which an anchor is introduced by its comparison to the target value (Tversky & Kahneman, 1974). The standard anchoring paradigm consists of two parts. The comparison question asks whether a numeric attribute of an object is higher or lower than the anchor value. For example, the question might ask whether the height of the Eiffel Tower is higher or lower than 800 meters. The absolute judgment question subsequently asks for the absolute value of the attribute. In our example, the absolute judgment question would ask for the height of the Eiffel Tower in meters. The anchoring effect means that a comparison with 800 meters would lead on average to higher estimates of the height of the Eiffel Tower than if the anchor was lower, such as 100 meters. The scale distortion theory argues that the anchor of 800 meters makes lower values seem relatively small in comparison and the height of the Eiffel Tower is consequently mapped to a higher numeric value on the scale than it would be if there was no anchor or if the anchor was lower.

The scale distortion theory has been supported by various findings. For example, an absolute judgment is shifted in the direction of a preceding attribute estimate of a different object on the same scale (Frederick & Mochon, 2012). This *sequential anchoring* could mean, for example, that the estimate of the height of the Eiffel Tower would be lower if it was preceded by an estimate of the height of Notre-Dame. The estimate of the height of Notre-Dame would serve as an anchor, influencing the subsequent target judgment in the direction of the anchor value. The scale distortion theory is also supported by the finding that a comparison of the target value to another object, rather than to an anchor, does not influence the absolute judgment of the target value in the standard anchoring paradigm, which shows that the anchor has to be numerical (Mochon & Frederick, 2013). An anchor also does not usually influence a subsequent estimate if it is made on a different scale (Frederick & Mochon, 2012). Moreover, a comparison of the anchor with a different object than the target in the comparison question influences the estimate of the target value similarly as when the target object is compared to the anchor directly (Frederick & Mochon, 2012; Mochon & Frederick, 2013). For example, the estimate of the price of a camera is similarly influenced by a preceding anchor when the anchor is compared to the price of a camera as when it is compared to the price of a GPS device (Mochon & Frederick, 2013). This finding again demonstrates that the numeric value of the anchor rather than the specific comparison drives the anchoring effect.

Furthermore, this finding suggests that the effect of the anchor has to occur during the estimate of the anchor value, because the target is not known at the time of the comparison in this experimental setup. The present study uses this observation to test a prediction of the

scale distortion theory of anchoring. If scale distortion influences an estimate during the absolute judgment, the scale has to be distorted at this point for the anchoring effect to occur. The absolute judgment question therefore has to be directly preceded by the comparison question for this assumption to hold. If other judgments on the same scale were made between the comparison and absolute judgment questions, the effect of scale distortion due to the comparison question would be correspondingly diluted. In the present experiment, several other comparisons on the same scale were inserted between the comparison question and the absolute judgment of the same target. According to the scale distortion theory of anchoring, the scale should not be distorted by an anchor at the point of the absolute judgment in this experimental design and the anchor should therefore have no effect.

Alternative accounts of anchoring make different predictions. For example, the selective accessibility model (Mussweiler & Strack, 1999; Strack et al., 2016; Strack & Mussweiler, 1997), argues that the comparison question makes information consistent with the anchor being the true value of the target attribute more accessible. This activated information influences the answer to the absolute judgment question. The selective accessibility model is therefore consistent with the anchoring effect even when multiple other anchors on the same scale are presented between the comparison and absolute judgment questions pertaining to the same target. The information activated by the comparison question could still be more accessible when the absolute judgment is made.

Other studies have already examined the delayed effect of anchoring. Mussweiler (2001) showed that a comparison of a target with an anchor influences the absolute judgment even after a week. Even though the result is not easily compatible with the scale distortion theory, participants in this study were not exposed to other anchors during the delay. Yoon and Fong (2019) have similarly shown that anchors influence valuation of goods even after eight weeks. Notably, Yoon and Fong used multiple anchors on the same scale. However, their study asked about valuation of goods, which is subjective, and the process of answering the comparison question might thus differ from general knowledge questions pertaining to an objective value of an object's attribute (Yoon et al., 2019). In particular, it has been shown that people do not have stable preferences and that preferences are instead constructed during valuation (Ariely et al., 2003; Slovic, 1995). Answering the comparison question may therefore require constructing the object's value, which is later recalled in answering the absolute judgment question. It is thus possible that different processes lie behind the anchoring effect in valuation of goods and in case of estimates of objective values. The present study therefore asked about estimates of objective values where comparisons could be made without making a precise estimate of the target value.

The goal of the present study was to extend the results of Yoon and Fong (2019), showing an effect of repeated anchoring on the same scale using estimates of objective values and thus inform theories of anchoring. While the effect would not rule out the scale distortion theory of anchoring, it would suggest that scale distortion is not necessary for the anchoring effect in the standard anchoring paradigm. Given concerns about generalizability

of psychological findings (Bahník & Vranka, 2017; Yarkoni, 2019), the present study used a larger pool of items and treated stimulus as a random factor, allowing for generalizability of its results to other similar stimuli. The experimental setup also allowed me to examine the effect of item position on the size of the anchoring effect. The questions between the comparison and absolute judgment questions for the same item differ between items in the initial and later positions. While they are interposed only by other comparison questions for the first item, they are interposed only by absolute judgment questions for the last item. If the anchoring effect is mostly reduced by interference from other anchors, it should be smaller for the initial items. If it is mostly reduced by interference from other absolute judgments, it should be smaller for the items presented later. However, possible order effects could be also driven by serial-position memory effects; i.e., recency and primacy effects. Finally, the consecutive absolute judgments allowed to assess the relative size of sequential anchoring by a previous absolute judgment and of standard anchoring by the comparison question.

## 2 Methods<sup>1</sup>

### 2.1 Participants

Five hundred and fifteen participants were recruited from a laboratory subject pool to participate in a batch of unrelated studies, one of which was the present study. Three data files were missing due to a technical error in another study, so the analysis was conducted with the data from the remaining 512 participants ( $Mdn_{age} = 23$ ,  $IQR_{age} = 6$ , 75% students, 65% women). The experiment was administered in groups of up to 17 and it was conducted in Prague, Czech Republic in November 2019. The planned sample size was 500, which was determined by requirements of other studies administered in the same session. The final sample size slightly differed because participants were invited for the sessions some time in advance.

### 2.2 Materials

The study consisted of two parts. In the first part of the study, participants were given 13 objects that they compared with a random anchor. The objects were selected to be either known to the participants (e.g., related to well-known Prague locations) or specified in a way that their characteristics could be reasonably estimated (e.g., “highest waterfall Angel Falls”). For each item, participants first generated a random number and then answered whether the given object was smaller or larger in terms of size in meters than the generated random number. The dimension of size was always specified to be length, height, or distance. The random generation was emphasized by a mechanism similar to a slot machine with three “wheels”, each with a single digit, that spun and then stopped on the number of

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<sup>1</sup>Pre-registration, software used for data collection, data, and analysis scripts can be found on: <https://osf.io/mf4bc/wiki/home/> and <https://osf.io/3t2hw/>.

the anchor. The anchors therefore ranged from 1 to 1000 (“000” on the wheels corresponded to 1000). The true size of all the objects in meters fell within this range. After this first part of the study, which presented comparison questions, participants made an absolute judgment of size of each object in meters in the second part. The order of objects was randomized for each participant, but it stayed constant between the two parts of the study.

### 3 Results

Based on a pre-registered exclusion criterion, 13 absolute judgments higher than 3000 were excluded as outliers. The analysis was conducted with the remaining 6635 answers. Mixed-effect linear regression with absolute judgment as the dependent variable and anchor as the independent variable was used in analysis. Random intercepts for participants and items were included in the model. Random slopes for the anchor value for items were also included in the model to take into account that the anchoring effect could differ between items. The anchor value was scaled to a range  $-0.5$  to  $0.5$ . The results showed a strong anchoring effect ( $t = 7.56$ ,  $b = 233.8^2$ , Wald 95% CI [173.2, 294.4]).

Influence of an anchor or a judgment from a preceding trial may show a possible effect of scale distortion caused by a previously considered value. An exploratory analysis showed that, absolute judgments were influenced by neither the anchor value on the previous trial ( $t = 1.27$ ,  $b = 18.1$ , CI [-9.7, 46.0]), nor the preceding absolute judgment ( $t = 2.05$ ,  $b = 34.7$ , CI [1.6, 67.8]),<sup>3</sup> nor the median of absolute judgments for the previous item ( $t = 1.39$ ,  $b = 28.5$ , CI [-11.7, 68.7]). The effect of the preceding absolute judgment was clearly positive when random slopes for the effect of the preceding judgment was not included in the model, that is, assuming that the effect is the same for all items ( $t = 3.20$ ,  $b = 35.1$ , CI [13.6, 56.7]).

In an exploratory analysis, the trial number (scaled to range from  $-0.5$  to  $0.5$ ) and its interaction with the anchor value were added in the model of possible order effects.<sup>4</sup> The resulting model suggested that judgments were generally lower in later trials ( $t = 1.93$ ,  $b = 23.7$ , CI [-0.4, 47.8]), and that the anchoring effect was somewhat smaller in later trials ( $t = -1.91$ ,  $b = -82.9$ , CI [-168.0, 2.2]); however, neither of the effects was at all robust. A visual inspection of the results (Figure 1B) suggested a possible quadratic effect of trial order. Correspondingly, the interaction of the squared centered trial number with the anchor value was clearly present ( $t = 3.50$ ,  $b = 550.1$ , CI [242.2, 858.0]), showing that the anchoring effect was larger for initial and later trials than for trials in the middle. Nevertheless, the

<sup>2</sup>Slope of the judgment in meters as a function of the full range of anchors,  $-0.5$  to  $0.5$ .

<sup>3</sup>The preceding absolute judgment was divided by 1000 before analysis to make the coefficients comparable with the reported anchoring effect.

<sup>4</sup>This and some other models did not include the full random-effects structure because the models with full random-effects structure led to a singular fit, suggesting overfitting of the data. In such cases, random effects were iteratively removed until a better fit was obtained. The final reported models are better than the original “maximal” models according to the Akaike information criterion.

anchoring effect was present for all trials (Figure 1B) and for all items (Figure 1A). The anchoring effect was therefore robust and was not limited to specific items or trial positions.

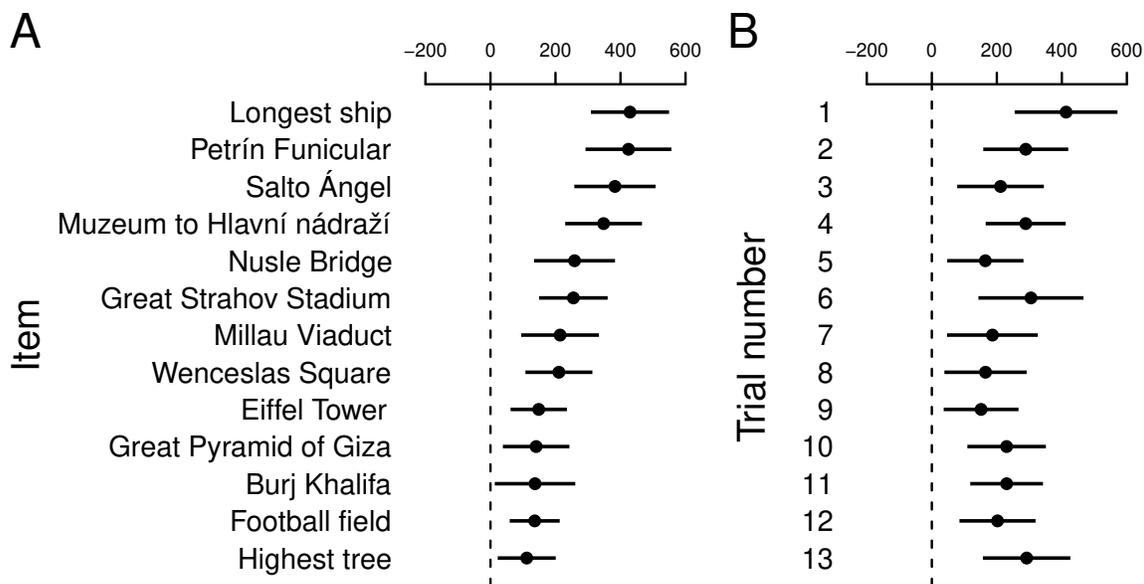


FIGURE 1: The size of the anchoring effect by item (A) and trial number (B). The points represent effect sizes — estimated differences between judgments for anchor values 1 and 1000 — and error bars represent 95% confidence intervals around them.

## 4 Discussion

The study presented participants with 13 comparison questions which were followed by absolute judgment questions related to the same objects. All the judgments were made on the same scale. Random anchors introduced in the comparison questions clearly influenced subsequent judgments even though they were interposed by a large number of unrelated judgments on the same scale. The anchoring effect was present for all the items and for all trial positions, suggesting robustness of the effect.

While the effect of the comparison question was robust, the effect of a previous absolute judgment was clearly present only when random slopes for items were not included. Generalizability of the effect to different items is therefore uncertain. Moreover, the effect of a previous absolute judgment was still much smaller than the effect of the comparison question. Furthermore, a preceding anchor or the median absolute judgment of a preceding item did not show any effect on absolute judgment. While sequential anchoring has been shown to be replicable (Bahník et al., 2019), these results suggest that its size is negligible in comparison to the standard anchoring effect.

The effect of the comparison question even after twelve questions on the same scale related to different items suggests that the effect of the comparison question is not primarily caused by scale distortion. If scale distortion played a large role in determining absolute

judgments, the absolute judgments would be influenced by the previous absolute judgment rather than by the comparison question. The scale on which an absolute judgment was made had been last used while answering the previous absolute judgment. Any distortion of the scale should have been therefore caused primarily by this previous absolute judgment. However, the effect of the previous absolute judgment was not robust and it might have been caused by the tendency to answer with similar values on trials close to each other — serial autocorrelation — rather than scale distortion. Analyses of the effects of a preceding anchor and of the median absolute judgment of a preceding item, which cannot be influenced by serial autocorrelation, but could still suggest scale distortion, did not yield significant results.

It could be argued that the anchor distorted the scale while participants answered the comparison question and that they formed their absolute judgments at that point. This explanation is incompatible with the finding that the comparison question usually influences the absolute judgment similarly independent of the target of the comparison question (Frederick & Mochon, 2012; Mochon & Frederick, 2013). The absolute judgment cannot be formed while answering the comparison question for it to influence the absolute judgment to the same degree independent of the target of the absolute judgment question. However, it is also possible that this insensitivity of the anchoring effect to the change of the target of the comparison question may have another explanation than mere operation of scale distortion. It would then be possible that participants in the current study had been influenced by scale distortion while answering the comparison question and then remembered their estimates formed at this stage. Alternatively, participants could have remembered the anchors and then retrieved them when making absolute judgments. The anchors would have then distorted the scale during absolute judgments.

The anchoring effect could have been also caused by scale distortion if participants used different scales for each item. For any absolute judgment, the last numerical value on the same scale would have then been the anchor presented in the comparison question. Mochon and Frederick (2013) argue that scale distortion occurs only when the targets of judgments fall within similar categories. For example, an estimate of the weight of a giraffe is influenced by a previous estimate of the weight of a raccoon, but not by an estimate of the weight of a tricycle. In the present study, all estimates were made in meters, but participants judged different attributes of different categories of objects. Yet, the anchoring effect was found for all objects, including those where multiple judgments related to the same attribute and similar categories of objects, such as the height of the Eiffel Tower, Burj Khalifa, Millau Viaduct, and Cheops Pyramid. If participants viewed each scale as different despite these similarities, any possible scale distortion effects would be much more circumscribed than previously thought.

Some other previous findings are also incompatible with the scale distortion theory. While the scale distortion theory argues that the effect of an anchor should be largely independent of the target of the comparison question and that only the numeric value of

the anchor matters, this has been shown not to be always the case (Bahník & Strack, 2016). The scale distortion theory also argues that scale distortion can occur only when an anchor is on the same scale as a subsequent judgment. However, an anchor can influence under certain conditions a subsequent judgment even when the two judgments are on different scales (Harris & Speekenbrink, 2016). Yet, it is still possible that anchoring works through scale distortion in some specific circumstances. For example, effects of sequential anchors are well explained by the scale distortion theory, while other accounts of anchoring are not readily compatible with them. For example, the selective accessibility model does not expect an unrelated sequential anchor to influence a subsequent target judgment given that the information activated by the anchor would not be usually relevant for the target judgment. Scale distortion could also contribute to the standard anchoring effect when there is no interference by other judgments on the same scale, even if such contribution is likely to be rather small.

While the linear effect of trial order was not significant, the apparent decrease of the anchoring effect may suggest that the interference by other absolute judgments is stronger than the interference by other comparison questions. However, it is also possible that the observed pattern of results could be caused by a memory effect. People similarly show worse recall for items presented later in a memory task. The observed quadratic effect of trial order is compatible with this explanation. The differences in effect sizes could be explained by primacy and recency effects in recall (Postman & Phillips, 1965). The role of memory has been also examined by Yoon and Fong (2019), who found that the anchoring effect was smaller after a delay. However, a correct recall of the anchor value as well as anchor repetition did not moderate the size of the anchoring effect in their study. These results suggest that, at least for anchoring in valuation of goods studied by Yoon and Fong, the effect of an anchor occurs mostly during the comparison question. The exact role of memory in anchoring in estimation of objective values is a topic for further research.

While the scale distortion theory does not seem to explain the present results well, the selective accessibility model is easily compatible with the findings. According to the selective accessibility model, participants would answer the comparison question by positive hypothesis testing (Chapman & Johnson, 1999; Mussweiler & Strack, 1999). They would consider whether the anchor could correspond to the target value and thus activate information that would be compatible with the equality. This activated information would still be more accessible during the absolute judgment question. Given that this information would be biased toward the anchor value, the absolute judgment question would be biased in the same direction. The order effects are easily compatible with memory effects for the information activated in the first part of the study.

Anchoring has also been argued to be a result of numeric priming (Wilson et al., 1996; Wong & Kwong, 2000). The numeric priming account does not appear to play a large role in most observed anchoring effects and studies supporting the role of numeric priming in anchoring tend to not be replicable (Brewer & Chapman, 2002; Klein et al., 2018; Newell

& Shanks, 2014; Shanks et al., 2020). It also does not explain the present results well. The absolute judgment question was divided from the anchor by other numeric values which would eliminate any possible numeric priming effect of the anchor value.

The anchoring-and-adjustment explanation argues that people reach their judgment by adjusting their estimates from an anchor value. This adjustment is generally insufficient, so the absolute judgment is biased in the direction of the anchor value (Epley & Gilovich, 2001, 2006; Lewis et al., 2019; Tversky & Kahneman, 1974). Operation of anchoring-and-adjustment is possibly compatible with the present findings, assuming that participants remembered anchor values from the first part of the study and adjusted their judgment from them in the second part of the study.

People could be also influenced by anchors because they believe that the anchors are informative. This mechanism of anchoring is usually ruled out in studies on anchoring by informing participants that the anchors had been chosen randomly. In the present study, participants were additionally informed about the range of possible anchors in advance; unlike in other studies, the anchors were truly random; and the randomness was further emphasized by using spinning wheels displaying the anchors. Despite these measures, participants could not directly check the random generation of anchors, so they could have disbelieved the information about their randomness. Participants treating anchors as informative could have therefore contributed to the observed anchoring effect.

A number of studies have shown the robustness of the anchoring effect. Anchors can influence judgment even after weeks or months (Mussweiler, 2001; Yoon & Fong, 2019). The anchoring effect is present even in experts in the judgmental domain (Englich & Mussweiler, 2001; Englich et al., 2006). An anchor can influence subsequent judgment even if it is clearly implausible (Strack & Mussweiler, 1997) or when it is compared to a different object (Frederick & Mochon, 2012; Mochon & Frederick, 2013). The present study showed that anchoring occurs even after a dozen of judgments on the same scale is interposed between the anchor and the corresponding absolute judgment.

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