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Do different anchors generate the equivalent anchoring effect? Comparison of the effect size among different anchors

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Abstract

Anchoring effect, the effect of precedent stimuli on subsequent numerical estimation, is one of the most studied topics in judgment and decision making. Many researchers have examined its psychological processes from many perspectives. However, few studies have directly compared strength of anchoring effects generated by different anchor types. The present study involved a behavioral experiment (numerical estimation task after presenting an anchor) and compared the effect size of anchoring effect on numerical estimations among different five anchors. We found that significant anchoring effect occurred only in two types of anchor. Common two features of these two anchors were representation of specific number and the dimensional equivalence between an anchor and a target in the numerical estimation task. Thus, these findings indicated that presentation of a specific number with dimensional equivalence as in the target of a numerical estimation task plays an important role in the generation of robust anchoring effect. Psychological mechanisms on generation of anchoring effect are discussed.

Keywords: anchoring effect; anchoring and adjustment model; numerical priming model; selective accessibility model

Introduction

In the research field of judgment and decision making, many studies have demonstrated that a prior presentation of a number can change a subsequent numerical estimation (Tversky & Kahneman, 1974). For example, in Tversky and Kahneman (1974), participants were asked to answer the following two questions: 1) judgement on whether the percentage of African nations in the United Nations is higher or lower than 65 percent (or 10 percent) and 2) estimation on the percentage of African nations in the United Nations. In this experimental procedure, when the high anchor (i.e., 65 percent) was presented in the first task, the median of the numerical estimation in the second task was 45 percent; in contrast, when the low anchor (i.e., 10 percent) was presented in the first task, the median of the estimation was 25 percent. Anchoring effect refers to people's numerical estimation being highly affected by the numerical value (anchor) presented before the estimation, resulting in biased numerical estimation depending on the anchors.

Previous studies have shown that an anchoring effect can be found in many situations (Mussweiler, Englich, & Strack, 2004). For example, it occurs in daily life such as in purchasing behavior in supermarkets (Wansink, Robert, & Stephen, 1998). Previous studies have shown that experts are also affected by anchoring effect (Northcraft & Neal, 1987).

Different types of anchor: Do they generate the equivalent anchoring effect?

Originally, the psychological mechanism of anchoring effect was explained by the model of anchoring and adjustment (Tversky & Kahneman, 1974). This model argues that, when presented with an anchor, people set its value as the basis (i.e., starting point) of numerical estimation and adjust the value in the plausible direction toward the target value. However, their adjustment tends to be insufficient. Thus, numerical estimation depends on the anchor (i.e., final estimation tends to be close to the anchor value), and biased numerical estimation is generated (Tversky & Kahneman, 1974). Anchoring effect is so robust that even implausible anchors can generate anchoring effect. For example, the estimation of Mahatma Gandhi's age was affected by the implausible anchor value of 140 (or 9) (Strack & Mussweiler, 1997). Furthermore, in Wong and Kwong (2000), the anchor "7300 m" induced a greater numerical estimate than did the anchor "7.3 km" although the two numbers indicated the same distance.

In the experimental procedure of the anchoring effect, anchor value was presented before the target numerical estimation. Since the anchor can be a prime in the priming paradigm, some argue that numerical priming is important for generating anchoring effect. (Jacowitz & Kahneman, 1995; Wilson et al., 1996; Wong & Kwong, 2000).

Some researchers, however, have argued that anchoring effect does not always occur, and that it can be explained by a selective accessibility model (Strack & Mussweiler, 1997; Mussweiler & Strack, 1999a, b, 2001; Mussweiler, Strack, & Pfeier, 2000). According to the selective accessibility model, a presented anchor activates semantic knowledge related to the anchor, and the activated knowledge affects subsequent numerical estimation. Based on this model, Strack and Mussweiler (1997) claimed that anchoring effect is a special case of semantic priming. In their study, participants were first asked whether the Brandenburg Gate is wider or narrower than 150 m (or 25 m) and were then asked about its height. In this case, they showed that significant anchoring effect did not occur. According to the selective accessibility model, these results can be explained as follows: In this experimental paradigm, the anchor represented a "width" dimension, and knowledge related to the width dimension was activated. In the numerical estimation task, participants were asked to make numerical estimation about the "height" dimension. Thus, anchoring effect was not generated since the activated knowledge was about the "width" of the gate, and such knowledge did not significantly affect numerical estimation of the "height" of the gate.

Taken together, previous findings can be summarized as follows. First, a number itself plays an important role in generating anchoring effect. Actually, since some researchers call the anchoring effect "numerical priming" (Jacowitz & Kahneman, 1995; Wilson et al., 1996; Wong & Kwong, 2000), presentation of the number may produce unique psychological processes for subsequent numerical estimation. Second, the meanings of the anchor also play an important role in the generation of anchoring effect. The selective accessibility model actually states that the activation of knowledge related to the target in the numerical estimation task is necessary to generate the anchoring effect.

So far, many researchers have discussed the psychological mechanisms of anchoring effects. Although many studies have focused on "mechanisms" of anchoring effect, no studies have directly examined the strength of anchoring effect among the different types of anchor in the same context. Thus, previous studies have not necessarily clarified how much effect (e.g., almost none, small, medium, or large) different types of anchor will generate. Furthermore, previous findings have not necessarily clarified the difference between anchoring and priming effects. As we described, some researchers have regarded anchoring effect as one type of priming effect (e.g., Jacowitz & Kahneman, 1995; Wilson et al., 1996; Wong & Kwong, 2000). Psychological studies have reported many types of priming effect. For example, semantic priming is one of the most known priming effects. In this priming effect, the number is not always presented as a prime. Thus, an empirical question remains about the difference in effect size between effects of semantic prime and anchor (i.e., numerical prime). Examination of these two issues will make a substantial contribution toward deep understanding of psychological mechanisms of the anchoring effect.

In the present study, we compared, through a behavioral experiment, the effect size of anchoring among different five anchors. In the following sections, we shall first explain the five different anchors we used in the behavioral experiment. After that, we shall report results of the behavioral experiment.

Experimental procedure and five anchors

Following the conventional procedure in experimental studies on anchoring effect, we conducted two tasks: precedent and numerical estimation tasks. In the precedent task, participants were asked to answer a simple task. Here, they were presented with an anchor. The content of task and anchor differed among the types of anchor. Then, participants were asked to answer the numerical estimation task.

We used the following five anchors in the behavioral experiment. Some were based on previous studies, and others were not examined in the previous studies. We first examined, by a Wilcoxon rank-sum test, whether significant anchoring effect could be observed or not for each anchor and calculated its effect size. We then compared the effect size of anchoring effect among the five anchors. We demonstrate the specific examples of the five anchors in the Appendix.

Numerical plus semantic anchor in the same dimension (NumSemSame) This dimensional equivalence anchor represents a number whose semantic dimension is the same as in the numerical estimation task. For example, when the numerical estimation is about height, the number of "height 150 m" is presented as anchor. Thus, this anchor was used as the most basic one for examining anchoring effect.

Numerical plus semantic anchor in the same dimension with high activation (NumSemSameHigh) This dimensional equivalence anchor is basically the same as NumSemSame except that a phrase such as "the height of a very tall gate 150 m" is added. According to the selective accessibility model, if an anchor strongly activates relevant semantic knowledge about the target in numerical estimation, this anchor may strongly affect numerical estimation. To the best of our knowledge, no previous studies have examined the effect of this anchor on numerical estimation.

Numerical plus semantic anchor in different dimension (NumSemDiff) This anchor represents a number whose semantic dimension differs from that in the numerical estimation task. For example, when the numerical estimation is about "the height," the number of "width 150 m" is presented as the anchor. According to Strack and Mussweiler (1997), this anchor will not produce significant anchoring effect.

Numerical anchor (Num) This anchor simply represents a numerical symbol. In the present study, participants were presented with a rather unclear symbol (see Appendix) and asked to give a number the symbol represented. Previous studies have not examined this type of anchor. According to numerical priming, this anchor may affect numerical estimation. However, the empirical question of whether this anchor affects numerical estimation remains.

Semantic anchor (Sem) This anchor only represents semantic meanings such as "the height of a very tall gate." This is the stimulus used in the basic priming paradigm. No previous studies have directly examined differences in effect size between numerical (i.e., anchoring effect) and semantic primes (i.e., priming effect).

Behavioral experiment

Method

Participants Six hundred and sixty-six Japanese (M_{age} = 44.93, SD_{age} = 8.77) participated in this experiment. They were recruited via a website and randomly assigned into one of 20 groups (See Table 1). Numbers of participants in the groups ranged from 30 to 36.

Task, stimulus, and procedure For the numerical estimation task, we set two goals: "the height of the Brandenburg Gate" or "the average weight of Czechs." There were 20 groups (two targets, five anchors, and high or low anchor value were crossed). Participants were first asked to answer the question in the precedent task and then answered the numerical estimation task. After these two questions, we also asked about subjective impression about the anchor presented. For example, participants were asked how they felt about the anchor value using a scale labeled "feel short (light, narrow, weak) very much" on the far left and "feel high (heavy, wide, strong) very much" on the far right. This rating scale contained 101 points. Furthermore, in case that participants know the correct answer for the target numerical estimation, their answers are not suitable for the present study. Thus, participants were also asked if they knew the correct answer for the numerical estimation task before this experiment.

Results and discussion

We excluded two pieces of data from the following analysis because their answers can be assumed to be outliers (these two answers—the estimation of the height of the Brandenburg Gate is 100000 m, 10000 m)—and excluded six others because participants knew the correct answers.

Examination of anchoring effect, and comparison of effect size

Figure 1 showed the distributions of the numerical estimations of the two targets in five types of anchor. Wilcoxon rank-sum test showed that, in both targets, participants in NumSemSame and NumSemSameHigh groups presented with the high anchor gave significantly higher numerical estimations than those presented with the low anchor (in the target of Brandenburg Gate, $p < .001$, z = 6.32 for NumSemSame, $p < .001$, z = 4.09 for NumSemSameHigh; in the target of Czechs, $p < .001$, z = 5.40 for NumSemSame, $p < .001$, z = 6.92 for NumSemSameHigh). However, in the other anchors, no significant effect was observed (in the target of Brandenburg Gate, p = .88, z = .14 for NumSemDiff, p = .25, z = 1.14 for Num, p = .10, z = 1.63 for Sem; in the target of weight of Czechs, p = .14, z = 1.49 for NumSemDiff, p = .14, z = 1.48 for Num, p = .74, z = .33 for Sem).

Anchoring effect was observed in NumSemSame and NumSemSameHigh but not in NumSemDiff, Num, and Sem, showing that not every anchor necessarily affects the subsequent numerical estimation.

Figure 2 shows the effect size of each anchor. Cohen (1988) discussed effect sizes as follows: small effect size: r = .10, medium effect size: r = .30, large effect size: r = .50. It was found that all effect sizes in NumSemSame and NumSemSameHigh were above .50, indicating that these anchors produced large anchoring effects. In contrast, effect sizes of NumSemDiff, Num, and Sem were around .10, indicating that effect sizes of anchoring effect generated by these anchors was small.

In sum, we found that not all anchors produced anchoring effects. In particular, anchors that represented specific numbers in the same dimension as in the target in the numerical estimation produced large anchoring effects. In contrast, a number, which was not related to the dimension in the target of the numerical estimation, did not have a significant effect. In addition, the semantic anchor, which was expected to activate knowledge relevant to the numerical estimation, did not produce significant effects.

Subjective impressions on anchor

Figure 3 exhibited the distributions of the ratings for the subjective impressions for the presented anchors. We examined whether each anchor produced different impressions between the high and low anchors. For the Brandenburg Gate problem, in four of the five anchors, participants in the high anchor group gave significantly higher ratings than those in the low anchor group (Wilcoxon rank-sum test). For the Czech problem, for all anchors, participants in the high anchor group gave significantly higher ratings than those in the low anchor group (Wilcoxon rank-sum test).

We found that participants presented with high anchors tended to subjectively feel higher to the presented anchor than those presented with low anchors. This results showed that high and low anchors activated some semantic knowledge related to the anchor. Given that differences in subjective impression between high and low anchors were observed in most cases, subjective impressions in the explicit level for the anchors did not always result in producing enough anchoring effect.

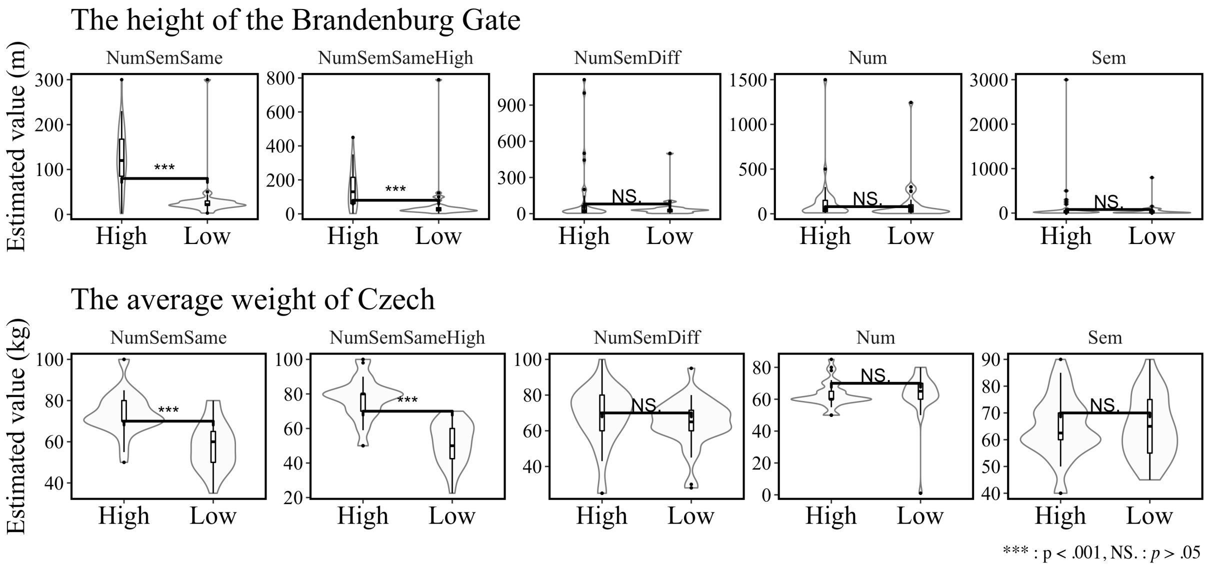

Figure 1: The distributions of the numerical estimations of two targets in five types of anchor.

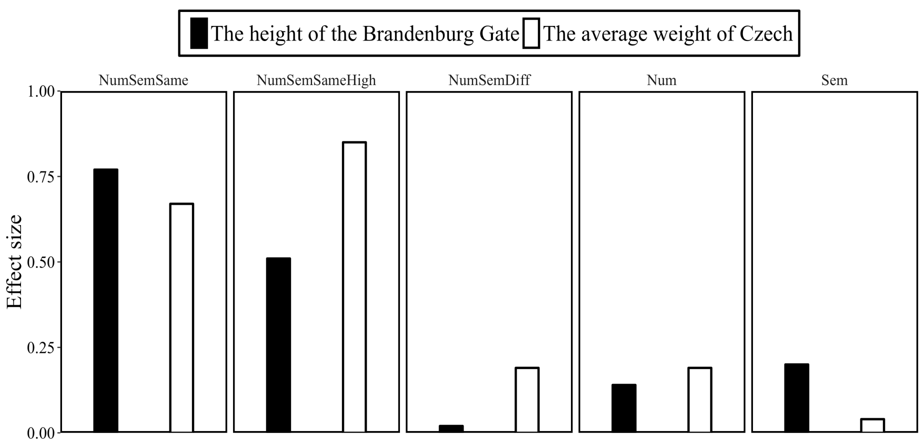

Figure 2: Effect size of anchoring effect generated by five types of anchor.

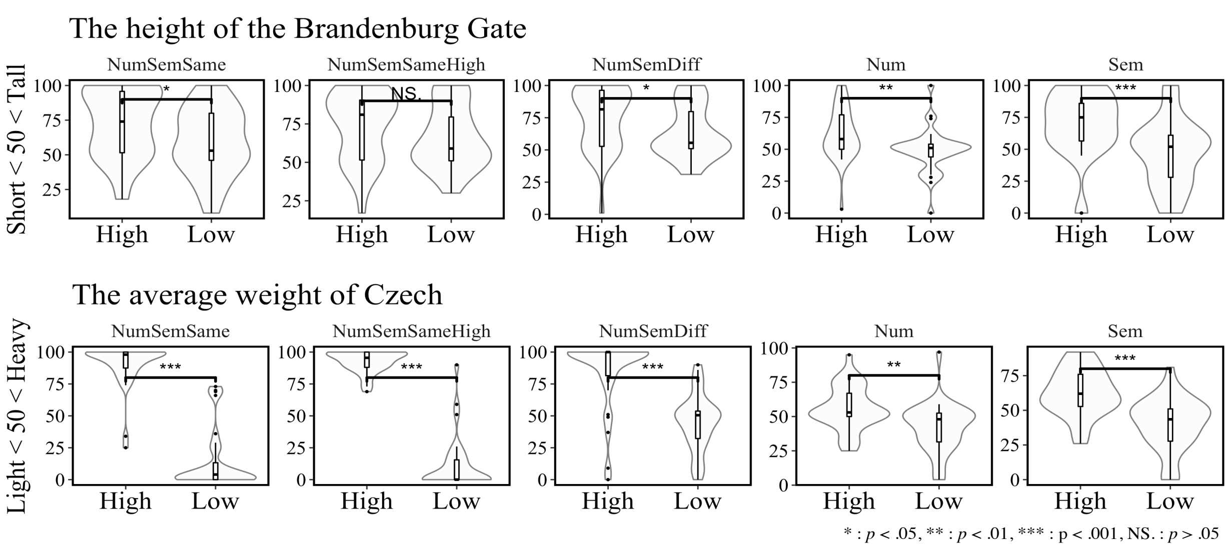

Figure 3: The distributions of the ratings for the subjective impressions for the presented anchor.

General discussion

The present study examined the effects of five different types of anchor on numerical estimations. Our main findings are summarized with the following two points. First, not all anchors produced anchoring effects. In particular, presentation of a specific number with dimensional equivalence as the target in the numerical estimation task produced large anchoring effect.

Second, activation of semantic meanings (i.e., presentation of a semantic anchor or adding semantic meaning to a numerical anchor) did not produce a large anchoring effect. This result suggests that, although anchoring effect and semantic priming are highly similar in the theoretical sense (e.g., Strack & Mussweiler, 1997), they are not equivalent in the practical sense (i.e., effect size).

Why do the anchors, which represent specific numbers with dimensional equivalence as in the target in the numerical estimation, generate the robust anchoring effect? In the research on judgment and decision making, it is well known that the compatibility between input and output is important. When the presented stimulus is more compatible with response, the presented stimulus affects the responses more strongly (Tversky, Sattath, & Slovic, 1988; Slovic, Griffin, & Tversky, 1990). For example, imagine the gamble, "You can get $100 with 40%" and then being asked, "How much is the highest price you can pay for playing the gamble?" It is well known that, for this question, people tend to be affected more strongly by the amount of money they can get in a gamble than by the probability. This is because the response (e.g., the highest price people can pay) is asked with the dimension of money. Analogous explanations can be applicable to the present findings; in the conventional anchoring paradigm, people are presented with a specific number and then make a numerical estimation. That is, anchor and response mode are highly compatible. The importance of the consistent dimension between the anchor and the target is also explained by this compatibility. Anchors such as NumSemDiff, Num and Sem, lack compatibility (i.e., compatibility in response mode or dimension between an anchor and a target in the numerical estimation). Therefore, the present findings indicate that compatibility is one of the key factors for whether anchors produce large effect on subsequent numerical estimation.

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Appendix: Presented anchors

In the following, we show examples of the five anchors in the precedent task for the Brandenburg Gate.

NumSemSame
Participants were asked to "please estimate whether the height 150 m (or the height 25 m) is taller or shorter compared to the height of the Brandenburg Gate."

NumSemSameHigh
Participants were asked to "please estimate whether the height of the very tall gate 150 m (or the height of the very short gate 25 m) is taller or shorter compared to the height of the Brandenburg Gate."

NumSemDiff
Participants were asked to "please estimate whether the width 150 m (or the width 25m) is wider or narrower compared to the width of the Brandenburg Gate."

Num
Participants were presented with a rather unclear number and asked to answer what number it represented (Figure 4 shows the numbers that were presented for high and low anchor groups respectively).

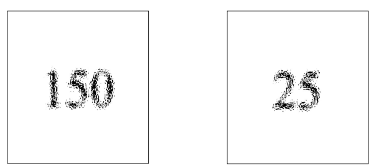

Figure 4: Number symbols presented in Num. High anchor on the left and low anchor on the right.

Sem
Participants were asked to "please estimate whether the height of the very tall gate (or the height of the very short gate) is taller or shorter compared to the height of the Brandenburg Gate."

Table 1 shows summaries of anchors in the present study.

Table 1: Summaries of anchors in the present study.

	Target of estimation			
	The height of the Brandenburg Gate		**The average weight of Czechs**	
Anchor	**High anchor**	**Low anchor**	**High anchor**	**Low anchor**
NumSemSame	The height 150m	The height 25m	The weight 150kg	The weight 25kg
NumSemSameHigh	The height of the very tall gate 150m	The height of the very short gate 25m	The very heavy person 150kg	The very light person 25kg
NumSemDiff	The width 150m	The width 25m	The grip 150kg	The grip 25kg
Num	150	25	150	25
Sem	The height of the very tall gate	The height of the very short gate	The very heavy person	The very light person