

# Subliminal anchoring: Judgmental consequences and underlying mechanisms<sup>☆</sup>

Thomas Mussweiler<sup>a,b,\*</sup>, Birte English<sup>b</sup>

<sup>a</sup> *University of Cologne, Germany*

<sup>b</sup> *University of Würzburg, Germany*

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## Abstract

Judgmental anchoring—the assimilation of a numeric estimate towards a previously considered standard—is an exceptionally ubiquitous effect that influences human judgment in a variety of domains and paradigms. Three studies examined whether anchoring effects even occur, if anchor values are presented subliminally, outside of judges' awareness. Studies 1 and 2 demonstrate such subliminal anchoring effects: judges assimilated target estimates towards the subliminally presented anchor values. Study 3 further demonstrates that subliminal anchors produced a selective increase in the accessibility of anchor-consistent target knowledge. The implications of these findings for the ubiquity of judgmental anchoring, its different underlying mechanisms, and comparative information processing are discussed.

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One of the most striking characteristics of human judgment is its comparative nature. When people evaluate a given target, they do so in comparison to a pertinent context, norm, or standard (Helson, 1964; Kahneman & Miller, 1986). No matter whether the target of judgment is as plain as the weight of an object (Brown, 1953) or as complex as the qualities of the self (Festinger, 1954), judges invariably rely on comparisons to construct their evaluations. One particularly ubiqui-

tous demonstration of this essential relativity of human judgment is the anchoring effect (Tversky & Kahneman, 1974)—the assimilation of a numeric estimate towards a previously considered standard (Mussweiler & Strack, 1999a). No matter whether judges guess the freezing-point of vodka (Epley & Gilovich, 2001), determine the price of a house (Northcraft & Neale, 1987), estimate the value of a car (Mussweiler, Strack, & Pfeiffer, 2000), or find a sentence of prison confinement in court (English & Mussweiler, 2001; English, Mussweiler, & Strack, in press-a), they are reliably influenced by salient numeric standards that anchor their judgment.

Such anchoring effects pervade a plethora of judgments, from the mundane (e.g., estimates of the freezing point of vodka; Epley & Gilovich, 2001) to the apocalyptic (e.g., estimates of the likelihood of nuclear war; Plous, 1989). In particular, anchoring has been observed in a broad array of different judgmental domains, such as general knowledge questions (Strack & Mussweiler, 1997; Wegener, Petty, Detweiler-Bedell, & Jarvis, 2001),

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\* Corresponding author. Fax: +45 0931/312812.

*E-mail address:* [thomas.mussweiler@uni-koeln.de](mailto:thomas.mussweiler@uni-koeln.de) (T. Mussweiler).

price estimates (Mussweiler et al., 2000; Northcraft & Neale, 1987), estimates of self efficacy (Cervone & Peake, 1986), probability assessments (Plous, 1989), evaluations of lotteries and gambles (Chapman & Johnson, 1994), legal judgment (Chapman & Bornstein, 1996; Englich & Mussweiler, 2001) and negotiation (Galinsky & Mussweiler, 2001). Not only is the anchoring effect influential in this variety of laboratory and real world settings, this influence is also remarkably robust. In particular, anchoring remains uninfluenced by many potentially alleviating factors. For one, anchoring occurs even if the anchor values are clearly uninformative for the critical estimate, for example because they were randomly selected (e.g., Mussweiler & Strack, 2000b; Tversky & Kahneman, 1974). Thus, even anchor values that judges randomly determined themselves by spinning a wheel of fortune (Tversky & Kahneman, 1974) or by rolling dice (Englich, Mussweiler, & Strack, *in press-b*; Mussweiler & Strack, 2000b) still influence judgment. Moreover, anchoring remains uninfluenced by the extremity of the anchor (e.g., Chapman & Johnson, 1994; Strack & Mussweiler, 1997; but see Wegener et al., 2001) so that even implausibly extreme values yield an effect. For example, estimates for the age of Mahatma Gandhi are assimilated even to an unreasonably high anchor value of 140 years (Strack & Mussweiler, 1997). Furthermore, anchoring effects are independent of participants' motivation to provide an accurate judgment (e.g., Wilson, Houston, Etling, & Brekke, 1996). And, anchoring is independent of judges' expertise (Englich & Mussweiler, 2001; Northcraft & Neale, 1987). In the legal domain, for example, trial judges with an average of more than 15 years of professional experience and inexperienced law students fall prey to anchoring to similar degrees (Englich & Mussweiler, 2001). In short, anchoring is an exceptionally robust phenomenon that is difficult to avoid.

Traditionally, such anchoring effects have been obtained by explicitly providing judges with a specific anchor and directly asking them to compare this anchor value to the target. In the standard anchoring paradigm (Tversky & Kahneman, 1974), this is achieved by posing a comparative anchoring question and asking participants to indicate whether the target's extension on the judgmental dimension is larger or smaller than the anchor value. In what is probably the best known demonstration of anchoring in this paradigm, Tversky and Kahneman (1974) asked their research participants two consecutive questions about the percentage of African nations in the UN. In a first comparative anchoring question, participants indicated whether the percentage of African nations in the UN is higher or lower than an arbitrary number (the anchor) that had ostensibly been determined by spinning a wheel of fortune (e.g., 65 or 10%). In the subsequent absolute anchoring question, participants then gave their best estimate of this percent-

age. Results show that the absolute judgments were assimilated to the explicitly provided anchor values. Ample empirical evidence demonstrates that explicitly instructing participants to compare the target to the provided anchor value in such a way, reliably yields assimilative influences (for overviews, see Chapman & Johnson, 2002; Mussweiler, Englich, & Strack, 2004; Mussweiler & Strack, 1999a).

More recent evidence, however, suggests that neither the anchor presentation nor the comparison to the target have to be made explicit for anchoring effects to occur. Even anchors that were not directly and explicitly related to the critical target do at times influence target evaluations. This may be the case if a particular value is clearly relevant (Northcraft & Neale, 1987), closely associated with the target judgment (Epley & Gilovich, 2001, 2004) or particularly accessible because of extensive prior use (Wilson et al., 1996). For example, real estate agents may anchor their estimates of property value on the listing price (Northcraft & Neale, 1987), because this is a clearly relevant figure. Furthermore, judges may anchor their estimates of the freezing point of vodka on the value of 32 °F (Epley & Gilovich, 2001), because this is a landmark figure that is closely associated with any freezing point estimate. Finally, judges may anchor their estimate of the number of fellow students who will get cancer on a high range of numbers because this range has been put on the top of their minds by extensive prior use (Wilson et al., 1996; but see Brewer & Chapman, 2002). Thus, anchoring effects appear to be more ubiquitous than was initially assumed: even anchors that are not explicitly provided for comparison influence judgment.

What are the limits of this striking ubiquity of anchoring effects? Does a potential anchor already yield an anchoring effect if judges are only fleetingly exposed to it? Imagine, for example, that while thinking about a potential selling-price for your old car, you hear a report on public radio claiming that the traditional German Bratwurst was invented more than 2300 years ago. Would such a fleeting exposure to a potential anchor influence your estimate about a reasonable price for your car? In the present research, we pushed this question a little further and examined whether an anchor which was exposed so fleetingly that it was—phenomenologically—not even there, would still influence judgment. Are numeric estimates influenced by anchor values that were not consciously perceived because they were presented outside of awareness? To find out, we subliminally primed participants who were in the process of evaluating a given target quantity with potential anchor values. If such subliminal values are indeed used as judgmental anchors, then—as is true for explicitly provided anchors—target evaluations should be assimilated towards them.

In fact, there are theoretical reasons to assume that this would be the case. Given that human judgment is

essentially comparative in nature (Helson, 1964; Kahneman & Miller, 1986), judges often make spontaneous comparisons between a given target and an accessible standard. When evaluating another person, for example, judges spontaneously compare a given target person to themselves (Dunning & Hayes, 1996), presumably because the self constitutes a chronically accessible standard. Similarly, when evaluating the self, judges spontaneously compare themselves to others who are easily accessible because they have been recently (Mussweiler & Bodenhausen, 2002) or frequently (Mussweiler & Rüter, 2003) activated. This suggests that accessible standards are often compared to a given judgmental target even if no comparison is explicitly asked for. Because subliminal standard presentation increases standard accessibility in much the same way as explicit presentation (Bargh & Pietromonaco, 1992), numeric standards that are subliminally primed may well be used as judgmental anchors. Judges who are subliminally primed with a high anchor value while searching for a relevant standard that may help them estimate the price of a car, for example, may thus well use this anchor for comparison. As a consequence, their estimate may be assimilated to the subliminal anchor.

At the same time, some empirical evidence casts doubt on this possibility. Specifically, it has been demonstrated that under specific conditions accessible anchor values that are not explicitly provided for comparison do not exert the typical assimilative anchoring effect. In a series of studies by Wilson et al. (1996), for example, anchors that were not explicitly compared to the judgmental target only influenced target judgments, if they had been extensively used prior to the estimation task. For example, numeric standards only influenced judgment, if participants had copied five pages of these numbers, not if they had copied only one page. This suggests that numeric standards may only be spontaneously used as judgmental anchors if their accessibility has been increased above a certain threshold (see also Brewer & Chapman, 2002).

It thus remains unclear whether subliminal anchoring may occur. In the present research we set out to examine the potential influence of subliminal anchors on human judgment. Studies 1 and 2 were designed to establish whether subliminal anchoring occurs. Study 3 was designed to examine the mechanisms that may contribute to such subliminal anchoring effects.

## Study 1

To examine whether subliminal anchoring may occur, we asked our participants to think about the annual mean temperature in Germany for 1 min. While doing so, they were subliminally primed with either a high or a low anchor value. If subliminal anchoring occurs, then

the subsequent temperature estimates should be assimilated towards these subliminal anchor values.

## Method

### Participants

We recruited 37 students at the University of Würzburg as participants. They were contacted over phone, asked to participate in a series of unrelated experiments that would last for a total of 1 h, and offered a compensation of €6.

### Materials and procedures

Upon arrival in the lab, participants were led to individual booths and seated in front of computer monitors. Participants worked on a series of unrelated experiments. The present study assumed the second position in the sequence of experiments and was preceded by a brief assessment of participants' social network. In the general instructions to the anchoring study, we informed participants that their task in this study would be to evaluate a given target along a specific dimension, so that they may, for example, be asked to evaluate the height of the Eiffel tower. We emphasized that participants should allow themselves sufficient time to make this evaluation. To ensure that they indeed do so, we would ask them to focus on a fixation point in the centre of the screen during the evaluation. This fixation point would be marked by a non-sense letter string, on which participants should focus throughout the evaluation. To remind them to keep focus, the letter string would flicker regularly. On the next screen, we informed participants that the specific evaluation we would ask them to make pertained to the annual mean temperature in Germany. To make this evaluation, they should carefully consider what the annual mean temperature in Germany may be. In doing so, they should focus on the fixation point (i.e., the letter string) in the middle of the screen. We emphasized that for the purpose of this study it was of crucial importance to keep focus on this fixation point throughout the evaluation.

The subsequent screen then presented the critical question: "What is the annual mean temperature in Germany" for 3 s and was followed by the screen with the fixation point ('MBUTGEPL') which was presented for a total of 60 s. After 3 s the letter string was overridden by the anchor value which was presented for 15 ms and was immediately masked by the same letter string which was then presented for 6 s. The anchor value reoccurred every 6 s for a total of 10 times.

In an independent pretest in which a different group of participants ( $N=16$ ) estimated the annual mean temperature in Germany without being exposed to an anchor value, the mean estimate was  $M=13.63$  °C ( $SD=2.61$ ). The anchor values were identical to those we had previously used in standard anchoring studies

where the anchor values are explicitly provided to participants in a comparative anchoring question (e.g., Mussweiler & Strack, 2000a). About half of the participants was subliminally exposed to the high anchor of 20 whereas the other half was exposed to the low anchor of 5. In line with most research on anchoring effects (Chapman & Johnson, 2002; Mussweiler et al., 2004), we did thus not include an unanchored control group in our experimental design. Such a control group may well help to determine whether estimates are indeed assimilated to both anchors. This, however, is not the primary concern of the present research, which was designed to demonstrate that subliminal anchors are effective in the first place. To make this point, it is sufficient to demonstrate that estimates of participants who were subliminally exposed to the high versus low anchors differ. Nevertheless, the unanchored estimate of our pretest participants can be used to examine whether participants' estimates were indeed assimilated to both anchors.

These procedures ensured that while generating their estimate about the annual mean temperature in Germany, participants were repeatedly exposed to either a high or a low subliminal anchor. After the final anchor presentation, the letter string was presented for a final 3 s. Subsequent to the priming task, participants reported their estimate of the annual mean temperature in Germany.

We used a funneled debriefing method to test for participants' awareness of the primes (Bargh, Chen, & Burrows, 1996). Participants answered a series of seven awareness check questions which progressively revealed the true nature of the priming task: (1) did you notice anything special in this study? (2) what do you think this study was about? (3) did you notice anything special with the fixation string? (4) did you notice that presentation of this letter string was interrupted? (5) do you have any idea of what the interruptions consisted? (6) in fact, the fixation letter string was interrupted by the very brief presentation of numbers. Were you able detect these numbers? (7) please write down the numbers you detected.

Two of the participants indicated their suspicion about the flickering of the letter string and were excluded from the data set.<sup>1</sup> None of the remaining participants reported any suspicion and no participant was aware of the anchor presentation.

### Results and discussion

We expected that the subliminal anchor presentation would yield the standard anchoring effect so that absolute estimates are assimilated to the anchor values. Our results are consistent with these expectations. Partici-

pants who were subliminally exposed to the high anchor value of 20 estimated the annual mean temperature in Germany to be higher ( $M = 14.89^\circ\text{C}$ ) than those who were subliminally exposed to the low anchor of 5 ( $M = 12.82^\circ\text{C}$ ),  $t(33) = 2.13$ ,  $p < .04$ ,  $r = .35$  (Rosnow, Rosenthal, & Rubin, 2000). The subliminally presented anchor values thus influenced estimates about the target quantity in much the same way as traditional anchoring procedures. Anchors that were presented so briefly that they could not even be consciously perceived still had a reliable effect on subsequent target evaluations.

### Study 2

In our second study, we set out to extend this finding in two important ways. First, we tested for the generalizability of the subliminal anchoring effect by examining whether similar effects can be obtained in an entirely different content domain, namely judgments about car prices. Second, we set out to provide further support for the subliminal nature of the primed anchor values. In addition to the funneled debriefing that is often used in social psychological research (e.g., Bargh et al., 1996), we engaged participants in a prime detection task. After completion of the anchoring task, participants were presented with 10 priming sequences, which were identical to those used in the critical priming task. Participants' task was to indicate for each sequence which of two possible anchor values had been presented. If participants' hit rate does not differ from chance level, this would provide additional evidence suggesting that the primed anchors were indeed subliminal.

### Method

#### Participants

We recruited 42 students at the University of Würzburg as participants. They were contacted in the University cafeteria and offered an ice cream cone as a compensation for participation.

#### Materials and procedure

Upon arrival in the lab, participants were led to individual booths and seated in front of computer monitors. Instructions pretended that the present study was concerned with people's ability to concentrate. Specifically, we would ask participants to think about a specific target. At the same time we would present them with a series of varying symbols on the computer screen and would subsequently ask them a number of questions concerning the target and the presented symbols. We emphasized that it was essential for participants to focus on the presented symbols while thinking about the target. We then instructed participants to think about the average price of a new midsize car and again emphasized

<sup>1</sup> Including these participants did not change the obtained pattern of results.

that for the purpose of this study it was of crucial importance to keep focus on this fixation point throughout the task.

The subsequent screen presented the critical question: “How many Euros does a midsize car cost on average” for 3000 ms and was followed by the screen with the fixation string. To ensure that the subliminal anchoring effects demonstrated in Study 1 are not specific to one particular subliminal priming paradigm, we used different fixation strings and presentation times in Study 2. Specifically, we used six varying fixation strings (e.g., and §§?#ß#, #?ß§§ and §) which were each presented for 1 s. After the third fixation string, the anchor value was presented for 33 ms and was immediately masked by the fourth string. This sequence was repeated 10 times so that the priming task lasted for a total of 60 s. As in Study 1, the anchor value thus reoccurred every 6 s for a total of 10 times.

In an independent pretest in which a different group of participants ( $N=16$ ) estimated the average price of a midsize car without being exposed to an anchor value, the mean estimate was  $M=18,312$  Euro ( $SD=4840$ ). About half of the participants was exposed to a high anchor of 30,000 whereas the other half was exposed to a low anchor of 10,000. After the priming task, participants reported their estimate of the average price of a midsize car in Euro. Subsequently, they answered the same funnelled debriefing questions (Bargh et al., 1996) used in Study 1. None of the participants reported awareness of the anchor presentation.

To further examine the subliminal nature of the prime presentation, participants worked on a final prime detection task. Following the funnelled debriefing questions, participants were informed that we would now present them with the exact same fixation strings as before. Their task would be to decide whether the numbers 10,000 or 30,000 were briefly presented in between these fixation strings. Participants were then presented with the exact same sequences used in the anchor priming manipulation. Again, 10 sequences consisting of the six different letter strings used before and lasting for 6 s each were presented. The anchor values were again presented for 33 ms in between the third and fourth fixation string. The anchors were selected at random and each anchor was presented five times. After each sequence, participants indicated whether 10,000 or 30,000 had been presented so that a total of 10 prime detection decisions was made. One participant was able to correctly detect all 10 primes in the detection task. Because for this participant it is not entirely clear whether the primes presented during the critical anchor priming task were indeed subliminal, he was excluded from further analyses.<sup>2</sup> The remaining participants detected between 2 and 9 with an

average of  $M=5.05$  ( $SD=1.69$ ) out of the 10 primes correctly, which does not differ from chance level,  $t(40)=.19, p>.8$ . Together with the results from the funnelled debriefing, this further suggests that across the remaining participants, our prime presentation was indeed subliminal.

### Results and discussion

Based on the findings of Study 1, we expected that estimates of the average price of a midsize car would be assimilated to the subliminally presented anchor values. Consistent with this expectation, participants who were presented with the high anchor value estimated the car price to be higher ( $M=21,219$  Euro) than those presented with the low anchor value ( $M=17,150$  Euro),  $t(39)=2.02, p<.05, r=.31$  (Rosnow et al., 2000).<sup>3</sup>

Using a second content domain and a more rigid control for the subliminal nature of anchor presentation, these findings demonstrate that subliminal exposure to anchor values reliably influences subsequent numeric judgments. Participants who were confronted with anchor values while thinking about the critical target assimilated their final estimates towards these anchors. Furthermore, the fact that participants were neither able to report the presented anchor values nor able to detect them above chance level, suggests that anchor presentation was indeed subliminal.

### Mechanisms of subliminal anchoring

Taken together, the results of Studies 1 and 2 demonstrate that subliminal anchoring effects do indeed exist. Anchor values that are presented outside of participants' awareness influence numeric estimates in much the same way as explicitly provided anchor values. But what are the psychological mechanisms that drive this subliminal anchoring effect? How do these anchor values, which—from the judges' perspective—are not even there, influence target evaluations?

In principle, at least three distinct psychological mechanisms may contribute to the effects of subliminal anchors. A first possibility is that subliminal anchoring effects are produced by insufficient adjustment from the presented anchor value. This would be consistent with Tversky and Kahneman's initial description of the anchoring phenomenon, in which they suggested that “[...] people make estimates by starting from an initial

<sup>2</sup> Including this participant did not change the obtained pattern of results.

<sup>3</sup> Additional analyses revealed that the magnitude of this anchoring influence is unrelated to participants' ability to detect values in the prime detection task. Specifically, the absolute distance between participants' estimate and the anchor value—an indicator of the extent to which participants assimilated their estimate toward the anchor—was unrelated to the number of primes participants detected,  $r=-.17, p>.28$ .

value that is adjusted to yield the final answer [...]. Adjustments are typically insufficient. That is, different starting points yield different estimates, which are biased toward the initial value.” (Tversky & Kahneman, 1974, p. 1129). Recent research, however, suggests that the scope of the insufficient adjustment account is limited to implausible anchors that are clearly unacceptable (for a more extensive discussion, see Mussweiler & Strack, 2001b). More specifically, it has been demonstrated (Epley & Gilovich, 2001) that insufficient adjustment only contributes to anchoring effects if the critical anchors are self-generated values which are clearly unacceptable because they pertain to a different target. For example, participants who are asked to estimate the freezing-point of vodka may self-generate the freezing point of water as an anchor from which they adjust until an acceptable value is reached. In contrast, the effects of acceptable values that are provided to participants do not appear to result from insufficient adjustment. Because the subliminal anchors that we used in the present research were clearly acceptable values for the target estimate, insufficient adjustment seems unlikely to be the underlying mechanism.

These subliminal anchoring effects may appear more consistent with an alternative account which assumes that anchoring effects are rather superficial and purely numeric in nature. In particular, it has been suggested that anchoring effects may be produced by mechanisms of numeric priming (Jacowitz & Kahneman, 1995; Wilson et al., 1996; Wong & Kwong, 2000). Increasing the accessibility of a specific anchor value may increase its chances to influence the subsequent target judgment. In the context of the present studies, subliminal priming of the anchor value may increase its accessibility, so that this value is more likely to come to participants' minds when generating the target judgment. Although a pure numeric priming account seems unable to account for many of the effects of explicitly provided anchors (for a discussion, see Mussweiler & Strack, 2001a), it may well contribute to the subtle effects of subliminal anchors.

Subliminal anchoring effects, however, may also be produced by accessibility mechanisms that are more semantic in nature. In our past research, we have suggested that anchoring effects are produced by mechanisms of selective accessibility (Mussweiler & Strack, 1999a, 1999b, 2000a; Strack & Mussweiler, 1997; for a related account, see Chapman & Johnson, 1999). More specifically, we have suggested that anchoring is in essence a knowledge accessibility effect. We assume that comparing the judgmental target to a provided anchor value changes the accessibility of knowledge about the target. In particular, the accessibility of an anchor-consistent subset of target knowledge is selectively increased. We assume that judges compare the target with the anchor by testing the possibility that the target's value is equal to the anchor value. For example, judges

who are asked whether the average price of a midsize car is higher or lower than 10,000 Euro are assumed to test the possibility that the average price actually is 10,000 Euro. To do so, they selectively retrieve knowledge from memory that is consistent with this assumption (e.g., “A small car may cost even less than 10,000 Euro.” “Korean cars are fairly inexpensive,” etc.) (Klayman & Ha, 1987; Trope & Liberman, 1996). As a consequence, the accessibility of anchor-consistent knowledge is increased. In order to generate the final numeric estimate, judges then rely primarily on easily accessible knowledge (Higgins, 1996; Wyer & Srull, 1989), so that their estimate is heavily influenced by the anchor-consistent knowledge generated before. In our example, absolute estimates about the average price of a car would thus be based on the specific subset of target knowledge that was deliberately retrieved to be consistent with the assumption that this price is fairly low. Conceivably, using this knowledge leads to low estimates, so that the final estimate is assimilated to the anchor value.

Recent anchoring research has provided ample evidence demonstrating that the effects of explicitly provided anchor values are indeed produced by this selective accessibility mechanism (for an overview, see Mussweiler & Strack, 2001a). The most direct support for this notion stems from studies which used lexical decision tasks to directly assess the accessibility of target knowledge subsequent to considering the anchor value (Mussweiler & Strack, 2000a). In one of these studies (Mussweiler & Strack, 2000a, Study 2), participants were asked to compare the average price for a German car to either a high or a low anchor value (40,000 vs. 20,000 German Marks). Subsequent to this comparative judgment, we assessed the accessibility of target knowledge with a lexical decision task. In particular, participants made a series of lexical decisions including target words that are closely associated with expensive cars (e.g., Mercedes, BMW) and words associated with inexpensive cars (e.g., VW). Our results demonstrated that response latencies for these two types of target words clearly depended on the anchoring condition. In particular, judges were faster in recognizing words associated with expensive cars after a comparison with the high anchor than after a comparison with the low anchor. In contrast, words associated with inexpensive cars were recognized faster after a comparison with the low anchor. These findings demonstrate that the accessibility of anchor-consistent knowledge about the target (e.g., knowledge indicating low prices after a comparison with a low anchor) is increased as a consequence of considering the anchor value.

To date, such selective accessibility effects have only been demonstrated for situations in which anchor values were explicitly provided and where judges were explicitly instructed to compare the anchor value with the target. In principle, however, selective accessibility may also

contribute to more subtle anchoring effects. This becomes particularly apparent, from the conceptual perspective of a two-stage model of judgmental anchoring (Mussweiler & Strack, 1999a, 1999b, 2001a; Wilson et al., 1996). In those cases in which no anchor value is explicitly provided for comparison, judges have to select an appropriate anchor in a first processing stage. In the case of subliminal anchoring, this selection process is likely to be influenced by mechanisms of numeric priming. Specifically, the subliminally presented value may be selected as an anchor because it is easily accessible and comes to mind during the evaluation of the target (Wilson et al., 1996). Notably, selecting an anchor by itself is not sufficient to use this anchor as a basis for target evaluation. In order for a selected anchor to be helpful for target evaluation, in a second comparison stage, it has to be related to the characteristics of the judgmental target. This process requires the activation of target knowledge and is—in light of the accumulated evidence (see Mussweiler & Strack, 2001a)—likely to involve the process of selective accessibility. Subliminal anchoring may thus be best conceived as a two stage process in which judges first select an accessible anchor and then compare this anchor to the target via mechanisms of selective accessibility.

If mechanisms of selective accessibility do indeed play a role in subliminal anchoring, then traces of this mechanism should also be apparent after subliminal exposure to anchor values. More specifically, the same selective increase in the accessibility of anchor-consistent information that results from explicit instructions to compare the target to the anchor value should also be apparent after subliminal exposure to an anchor value. Judges who have been subliminally exposed to a high anchor value while thinking about the average price of a car should thus have information indicating high car prices (e.g., a Mercedes costs a lot of money) on the top of their mind. Judges who have been subliminally exposed to a low anchor value, however, should have information indicating low car prices (e.g., Korean cars are often quite cheap) particularly accessible. We designed Study 3 to test for this possibility and to thus examine whether mechanisms of selective accessibility may also be involved in subliminal anchoring.

### Study 3

Specifically, we adapted the lexical decision task that we have previously used to examine selective accessibility in the context of explicitly provided anchors (Mussweiler & Strack, 2000a) to the subliminal anchoring paradigm. Participants were subliminally presented with a high or a low anchor value while thinking about the average price of a midsize car. Subsequently, they made lexical decisions about words associated with expensive

and inexpensive cars. If subliminal anchor presentation leads to a selective increase in the accessibility of anchor-consistent knowledge, then participants who had been exposed to the high anchor should be faster in recognizing words associated with expensive rather than inexpensive cars. For participants who had been exposed to the low anchor, however, the reverse should be the case.

### Method

#### Participants

We recruited 37 students at the University of Würzburg as participants by contacting them over phone and offering them a compensation of 6 Euro.

#### Materials and procedure

For the most part, instructions and anchor presentation were identical to Study 1. The critical evaluation, however, pertained to the average price of a new midsize car, used in Study 2. Because Study 3 was run before the introduction of the Euro as a daily currency, the estimates pertained to German Marks and the anchor values were consequently higher. Specifically, we used the same anchor values as in our previous work on supraliminal anchoring effects (Mussweiler & Strack, 2000a). The high and low anchor values were 20,000 and 40,000 respectively (about 9000 and 18,000 US\$ at the time).

Furthermore, we altered the general instructions to alert participants to the lexical decision task that would follow the evaluation task. In particular, participants were informed that subsequent to the evaluation we would assess their momentary cognitive performance level with the help of a task in which they were to decide as fast as possible whether a particular letter string does or does not constitute a word of the German language. To indicate their decision they should press the blue and yellow keys on the computer board. To allow them to do so as fast as possible, they should keep their left and right index finger on the critical keys throughout the lexical decision task. We emphasized that participants should try to make their decisions as fast and as accurately as possible.

Subsequent to instructions, participants first worked on the evaluation task, during which anchor values were subliminally presented in the same way as in Study 1. Instead of providing their absolute estimate after the anchor values had been presented for the last time, however, they proceeded with the lexical decision task which was modeled after the task we have used in our previous work on supraliminal anchoring (Mussweiler & Strack, 2000a). Before the first lexical decision trial, we reminded participants to put their left and right index fingers on the critical computer keys. A fixation point ('XXXX') appeared in the centre of the screen for 1500 ms and was overridden by the target word which remained on the screen until participants had indicated their response.

After a break of 2000 ms this sequence was repeated with a new target word.

A total of 26 letter strings was presented, including five words that are closely associated with expensive cars ('Mercedes,' 'BMW,' 'Limousine,' 'Klima' [AC], schnell [fast]), five words that are closely associated with inexpensive cars ('Fiesta,' 'Golf,' 'langsam' [slow], 'VW,' 'Opel'),<sup>4</sup> 10 neutral words (e.g., Papier [paper], schreiben [write]) and six non-words (e.g., narmom, terken). These words were selected on the basis of a pretest involving 16 participants who did not participate in the main study. In the instructions, these participants were informed that the purpose of the pretest was to find words that are associated with cars. For each word, they rated on a 9-point scale ranging from  $-4$  (strongly associated with inexpensive cars) to  $+4$  (strongly associated with expensive cars), how strongly each word is associated with the two critical categories. The expensive car words were rated to be more strongly associated with expensive cars (ratings higher than 2). The inexpensive car words were rated to be more strongly associated with inexpensive cars (ratings lower than 0).

After completion of the lexical decision task, participants immediately proceeded with the awareness check. Thus, in the context of Study 3 we did not ask participants to provide an estimate of the average car price. This is the case, because the lexical decision task which we used to assess knowledge accessibility simultaneously manipulates knowledge accessibility. Specifically, by presenting participants with anchor-consistent and anchor-inconsistent words, the lexical decision task provides them with judgment-relevant knowledge that is likely to directly influence subsequent target judgments. In fact, previous research has demonstrated that manipulations of knowledge accessibility that are independent of the anchor manipulation clearly influence target judgments (e.g., Chapman & Johnson, 1999; Mussweiler et al., 2000). In light of these findings, anchoring effects that are obtained subsequent to the lexical decision task are difficult to interpret. Because of these ambiguities and because the judgmental consequences of subliminal anchoring were clearly demonstrated in Studies 1 and 2, we focused exclusively on the selective accessibility consequences of subliminal anchoring in Study 3. To assess participants' awareness of the primes at the end of the study, we used the same funneled debriefing questions (Bargh et al., 1996) as before. None of the participants reported awareness of the anchor presentation.

In sum, Study 3 is based on a  $2$  (Anchor: high vs. low)  $\times$   $2$  (Word: associated with expensive versus inexpensive cars) mixed factorial design. Participants were subliminally exposed to either a high or a low anchor value and then worked on a lexical decision task includ-

ing words associated with expensive and inexpensive cars.

### Results and discussion

To control for outliers, we excluded response latencies that deviated by more than three standard deviations from the respective target mean from further analyses.

We expected that participants would be faster in recognizing anchor-consistent rather than anchor-inconsistent target words in the lexical decision task. Consistent with this assumption, inspection of Fig. 1 reveals that participants who had been subliminally presented with the high anchor were indeed relatively faster in responding to words that are associated with expensive cars ( $M = 659$  ms) than to words associated with inexpensive cars ( $M = 686$  ms). Participants who had been exposed to the low anchor values, however, were relatively faster in responding to words associated with inexpensive ( $M = 700$  ms) rather than expensive cars ( $M = 763$  ms). This pattern was borne out in a significant interaction effect,  $F(1, 35) = 4.28$ ,  $p < .05$ ,  $r = .33$  (Rosnow et al., 2000), in a  $2 \times 2$  mixed model ANOVA, using participants' response latencies for the lexical decisions as the dependent measure. In this analysis none of the remaining effects reached significance, all  $F < 1$ .

These findings demonstrate that the subliminal presentation of an anchor value during target evaluation leads to a selective increase in the accessibility of anchor-consistent target knowledge. Participants who had been exposed to a high anchor value had knowledge implying fairly high car prices more accessible than knowledge implying low car prices. For participants who had been exposed to a low anchor value, however, the reverse was the case. As is true for anchor values that are explicitly provided for a comparison with the target, subliminally presented anchors thus lead to increased accessibility of a selective (anchor-consistent) subset of target knowledge. Our previous research (e.g., Mussweiler & Strack, 1999b; Strack & Mussweiler, 1997) demonstrates that

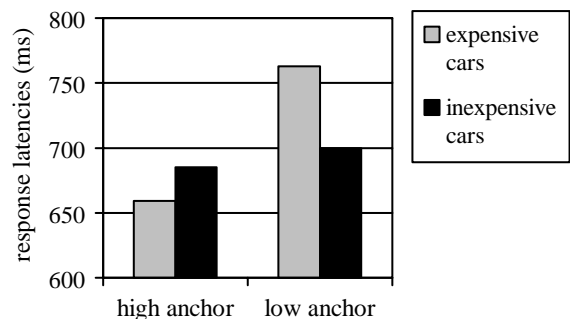


Fig. 1. Response latencies (ms) for lexical decisions for words associated with expensive and inexpensive cars after subliminal presentation of a high versus low anchor (Study 3).

<sup>4</sup> Fiesta, Golf, Opel, BMW, Mercedes, and VW are well known car makes and models in Germany.



this selectively accessible target knowledge is used as a basis for subsequent target estimates and consequently produces the typical assimilation to the anchor. In combination with this earlier research, the present findings suggest that mechanisms of selective accessibility may also contribute to subliminal anchoring effects.

At the same time, it is important to note that this finding can only be seen as providing initial suggestive evidence that hints at the potential role of selective accessibility in subliminal anchoring. The present findings clearly demonstrate that subliminal anchors increase the accessibility of anchor-consistent target knowledge. It is less clear, however, whether it is this selective accessibility effect that actually drives the judgmental consequences of subliminal anchor presentation. In principle, one may argue that the selective accessibility effect merely constitutes an epiphenomenon, which coexist with but does not directly produce the judgmental effects. Although we cannot rule out this possibility on the basis of the current findings, this seems rather unlikely. For one, it seems natural that judges who are trying to generate an estimate about the target quantity would make use of accessible target knowledge. Because this knowledge was self-generated so that it is unlikely to be seen as a biasing influence there is little reason for judges to ignore it (Mussweiler & Strack, 1999b; Mussweiler & Neumann, 2000). Furthermore, previous work on explicitly provided anchors has demonstrated that judges do indeed use accessible target knowledge as a basis for their target estimates (for an overview, see Mussweiler & Strack, 2001a). This is, for example, apparent in the fact that the time judges need to generate their estimate is inversely related to the amount of knowledge that has previously been rendered accessible (Mussweiler & Strack, 1999b; Strack & Mussweiler, 1997). These empirical findings and theoretical considerations suggest that the knowledge that was rendered accessible as a consequence of subliminal anchor presentation, would also contribute to its judgmental effects.

## General discussion

In the present research, we have examined subliminal anchoring effects. Our findings demonstrate that numeric standards that were presented outside of judges' awareness during the evaluation of a target influence the final judgment. As is true for explicit anchors that were directly provided for comparison with the target, estimates of the target quantity were assimilated towards the subliminal anchor values. Judges to whom a high anchor of 30,000 Euros was subliminally presented while thinking about the value of a car, for example, estimated this value to be higher than those who were presented with a low anchor of 10,000 Euro. Furthermore, the results of Study 3 demonstrate that subliminal anchors

produce a selective accessibility effect in knowledge about the judgmental target. Again, as is true for explicit anchors that were directly provided for comparison, anchor-consistent knowledge was selectively rendered accessible. Judges who were subliminally primed with a high anchor thus had knowledge that is associated with high car prices more accessible than knowledge that is associated with low car prices. These findings extend research on judgmental anchoring in specific, and comparison processes in general in important ways.

First, these findings demonstrate that anchoring effects may be even more ubiquitous than is typically assumed. Anchoring has been described as a phenomenon that influences human judgment in a variety of different domains using a variety of different paradigms. All of the previous findings, however, have focused on the effects of anchors of which judges were aware. In fact, most of the anchoring research has examined the effects of anchors that were explicitly provided for a comparison with the judgmental target (for reviews, see Chapman & Johnson, 2002; Mussweiler & Strack, 1999a). The present research demonstrates that anchors which were presented so fleetingly that judges remained unaware of them may still influence target estimates. This suggests that judges neither have to be aware of a given anchor, nor do they have to be explicitly instructed to compare it to the target, for anchoring effects to occur.

At first sight, this finding appears to be inconsistent with previous demonstrations of potential limits to judgmental anchoring. As we have pointed out before, Wilson et al. (1996) demonstrated that anchors that were not explicitly provided for comparison only influenced judgment, if their accessibility had been increased above a certain threshold by extensive use in a prior task. In the present research, however, subliminal anchor presentation was sufficient to produce reliable anchoring effects. There are at least two attributes of the present studies that may help explain this apparent inconsistency. For one, in the present paradigm we presented anchor values 10 times before each target evaluation. Typically, the accessibility of a concept as well as the judgmental effects it produces increase with the number of prime presentations (Srull & Wyer, 1979). This suggests that repeated presentation may be sufficient to increase anchor accessibility above the critical threshold. Furthermore, we presented the anchor values while participants were thinking about the target estimate. In contrast to the paradigm used by Wilson et al., where participants were confronted with the anchor value before engaging in the critical judgment process, our participants thus processed the critical anchor value and the critical estimate in parallel. In light of the fact that the coaccessibility of two concepts may be an important precondition of comparison activity (Kruglanski & Mayselless, 1990), this parallel processing may be crucial. Specifically, being in

the process of evaluating the judgmental target during anchor exposure may ensure that the anchor value is indeed related to the target, which is a precondition for anchoring effects to occur. Future research will have to further explore the exact interplay of these processes.

The ubiquity of judgmental anchoring that is apparent in the present research also has important implications for a number of phenomena in organizational behavior. Anchoring effects have been demonstrated to influence a number of phenomena that play an important role in organizations. In fact, anchoring effects influence a broad array of phenomena ranging from negotiations (Chertkoff & Conley, 1967; Galinsky & Mussweiler, 2001; Huber & Neale, 1986) over goal setting (Hinsz, Kalnbach, & Lorentz, 1997) to pricing decisions (Mussweiler et al., 2000; Northcraft & Neale, 1987). Some of the studies demonstrating how anchoring effects may influence important aspects of organizational behavior have provided the critical anchors in subtle ways. In their studies demonstrating anchoring influences on pricing decisions of real estate agents, for example, Northcraft and Neale (1987) presented anchor values together with abundant background information about the house that was to be priced. Similarly, in work on anchoring effects in negotiations, a potential anchor is often presented in a subtle way, for example, as the opening offer of the negotiation partner (Galinsky & Mussweiler, 2001). The present work suggests that anchors that are presented in even more subtle ways may still influence organizational behavior. Specifically, real estate agents may well estimate the price of a house to be higher if they happen to have a high number on their mind during the estimation process. Similarly, negotiation partners may settle for a higher price if a high number happens to be on their mind during the negotiation. While these speculations are consistent with the present findings, they clearly have to be substantiated by future research which further specifies the applied implications of subliminal anchoring effects.

The present studies not only speak to the ubiquity of anchoring effects as such, but also to the ubiquity of the selective accessibility mechanism. To date, selective accessibility effects have mostly been demonstrated for the standard anchoring paradigm (Tversky & Kahneman, 1974) in which the anchor is explicitly provided for comparison with the target. As a consequence, it has been speculated that the mechanisms of selective accessibility may only contribute to anchoring effects obtained in this specific paradigm, (Epley & Gilovich, 2001, 2004). The results of Study 3, however, demonstrate that selective accessibility effects can equally be obtained outside of the standard anchoring paradigm. In fact, even in a situation in which no explicit comparison of target and anchor is asked for, is the accessibility of anchor-consistent target knowledge selectively increased. This finding

is consistent with evidence demonstrating that selective accessibility effects also result from spontaneous comparisons in other judgmental paradigms, such as social comparison (e.g., Mussweiler & Bodenhausen, 2002; for a discussion, see Mussweiler, 2003). Selective accessibility may thus be a core mechanism of anchoring and comparison mechanisms in a variety of different domains and paradigms.

Going beyond the anchoring phenomenon, the present research also echoes theoretical considerations and empirical evidence demonstrating the essential relativity of human judgment. Theorizing in different areas of psychology (Festinger, 1954; Helson, 1964; Kahneman & Miller, 1986) has suggested that when evaluating a given target, judges use salient standards for comparison and abundant research has demonstrated this inclination for comparative information processing. The present findings extend these perspectives by demonstrating that judges' proclivity towards comparative processing goes so far that they even use comparison standards which—phenomenologically—are not even there as a basis for target evaluation. Comparison processes may thus play an even more central role in human judgment than is typically assumed.

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