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Effects of main actor, outcome and affect on biased braking speed judgments

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Abstract

Subjects who judged speed in a driving scenario overestimated how fast they could decelerate when speeding compared to when keeping within the speed limit (Svenson, 2009). The purpose of the present studies were to replicate studies conducted in Europe with subjects in the U.S., to study the influence of speed unit (kph vs. mph), affective reactions to outcome (collision) and identity of main actor (driver) on braking speed judgments. The results replicated the European findings and the outcome affective factor (passing a line/killing a child) and the actor factor (subject/driver in general) had significant effects on judgments of braking speed. The results were related to psychological theory and applied implications were discussed.

Keywords: overconfidence, driving speed, braking, affect heuristic, traffic safety.

1 Introduction

Much of the dynamics of the world we live in can be described by statistical and mathematical relationships and we have to learn them at least approximately to get along. Sometimes the approximations lead us astray, as demonstrated by the literature on heuristics and statistical biases (Gilovich, Griffin & Kahneman, 2002). Even if a relationship is without uncertainty, as in the case of exponential growth, approximative and intuitive judgments may lead to strong biases (McCloy, Byrne & Johnson-Laird, 2010; Peer, 2010a,b; Svenson, 2008, 2009; Svenson, Eriksson & Gonzalez, 2012; Svenson, Erikson, Salo & Peters, 2011; Wagenaar, 1975). One such relationship describes the deceleration of a car from the point the driver has realized that she or he has to brake to the point where the car reaches a complete stop. Figure 1 shows speed (kph) as a function of distance (m) from the location of a car where a driver becomes aware of an obstacle and starts braking. The different curves describe initial speeds from 30 kph to 110 kph for a driver-car reaction time of 1 sec until the brakes start to apply. The friction coefficient between tires and road surface is 0.8.

The previous studies of this relationship were conducted in Europe, and speed was described in kph. The purpose of the first study was to test how general these results were by replicating them with subjects who measure speed in mph instead of kph. In the second study, we asked whether intuitive quantitative judgments based on the same physical parameters can be influenced by the outcome of a scenario. Here, we also asked whether the identity of the main actor in a scenario (the subject, or a general driver) would influence such judgments.

Svenson and colleagues reported that drivers overestimated how quickly they could bring down speed by braking if they were speeding (e.g., 40 kph) compared to braking at the speed of the speed limit (e.g., 30 kph) (Svenson, 2009; Svenson, Eriksson & Gonzalez, 2012). In their studies, the subjects were instructed that from a given lower speed (e.g., 30 kph), a driver could stop her car right in front of a marking or an obstacle in the street by braking maximally hard. If the car moved faster than this speed, the driver would not be able to stop at the same spot. Drivers were asked to imagine that they were driving faster (e.g., 50 kph compared to 30 kph) and that they suddenly saw the same line or obstacle at the exact same place as before at the lower speed and started to brake as before. At what speed would the car hit the object or pass the line (Svenson, 2009, Svenson, Eriksson & Gonzalez, 2012)? The problems were presented in instructions communicating the following.

> The stopping distance increases with higher driving speed. Imagine yourself driving past a school with a 30 kph speed limit at a speed of 30 kph when a child unexpectedly runs into the street. You are an alert driver and start to brake maximally with a reaction time of 1 second, the street is dry with good friction and you are able

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> to stop just in front of the child. Now imagine the same scenario, only this time you are speeding and driving past the school at 50 kph. Your reaction time and conditions are the same as before, however, as your speed increases so does your stopping distance, therefore you will not be able to stop in time and consequently you will run over the child. Your task is to estimate the speed at which you will hit the child.

According to normative physics the stopping distance depends partly on a linear component related to speed (during the driver's reaction time before she or he starts to brake) and partly on a component that is depending on braking force, friction, and the speed squared (e.g., Carlsson, 2004). The formulas for calculating the speed from the time of a stopping signal until a stand still of a car is the following, in which t_0 is the driver's reaction time and V stands for speed at a given moment in time t, after the driver sees a sign or an obstacle and starts to brake.

$$V = V_0 \qquad for\ t < t_0 \qquad (1)$$

$$V = (V_0^2 - 2g\mu(D - V_0 t_0))^{0.5} \qquad for\ t \geq t_0 \qquad (2)$$

The driver gets the impulse to stop, at speed V_0 . The second part $(V_0^2 - 2g\mu(D - V_0 t_0))^{0.5}$ describes the speed at distance D from the point where the driver first got a signal to stop, g is gravity and μ the friction between tires and the road surface. The stopping distance can be calculated by inserting V = 0 in equation (2). This equation is valid for a road without any shifts in elevation. A friction coefficient of $\mu = 0.8$ for hard braking on a dry asphalt surface describes good braking conditions and it is reasonable to assume a driver braking reaction time of at least 1.0 sec in this applied context. According to the formulas, when driving speed is increased, stopping distance increases following a nonlinear increasing function described by equation (1), (2) and Figure 1.

The results from the earlier studies with speeds stated in kph showed that drivers significantly underestimated the speed (Svenson, 2009; Svenson, Eriksson & Gonzalez, 2012). There may be several reasons for this. First, the function predicting braking speed is quite complex and it is therefore hard to approximate even if it was familiar in a theoretical sense (Svenson, 2009). From a perspective of driving experience, most drivers who have exceeded the speed limit have not had accidents when speeding. Secondly, braking normally takes place relative to other vehicles or as a reaction to predictable road characteristics. Also, in the case with unexpected risky events like the one in the child scenario, it is not easy to learn by experience as it is not a reoccurring event in normal everyday driving.

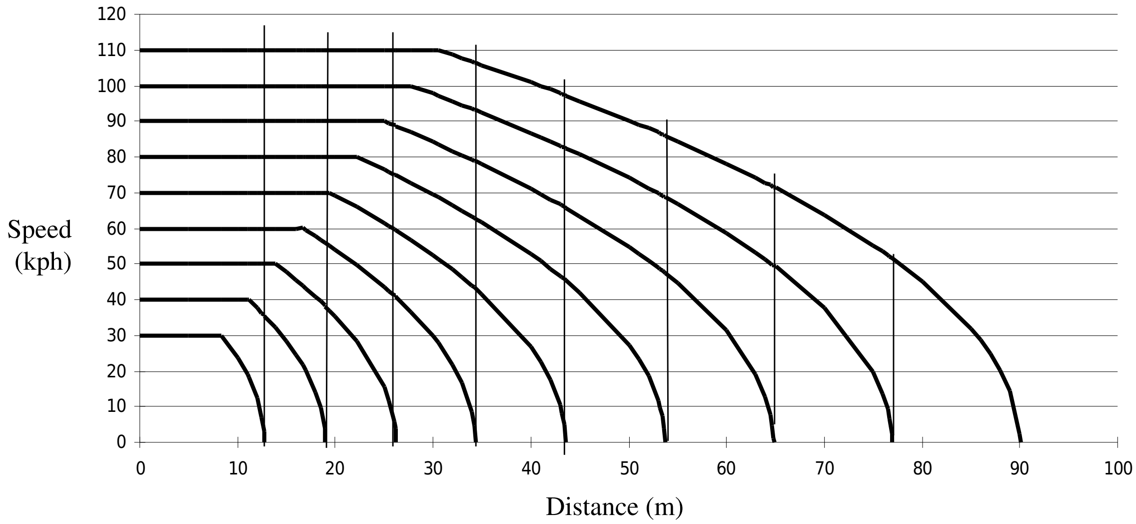
In the first study, we asked whether braking judgments made by U.S. subjects who are used to express speed in mph were exposed to the same kind of judgment bias as Swedish subjects. In order to transform a speed expressed in miles per hour to kilometers per hour, a value needs to be multiplied by approximately 1.6. The same speed is represented by a higher numerical value when expressed in kph than mph. It is natural to draw a parallel with the money illusion. Speed in mph is a "stronger speed currency" than kph, which means that smaller numbers mean higher physical speeds than the same numbers in kph. The money illusion describes how, e.g., change of a currency affects perception and willingness to pay (Wertenbroch, Soman & Chattopadhyay, 2007). When prices are given in a new currency and the units are worth more than in the old currency, the typical effect is acceptance of higher prices which are given in smaller numbers in the new currency. Part of this effect may be explained by novelty and part by a number magnitude effect.[1] In the present context, only the latter effect applies and predicts that, because miles per hour is expressed in smaller numbers than kilometers per hour, subjects' speed judgments should be higher when expressed in mph (Burson, Larrick & Lynch, 2009). This was the hypothesis tested in Study 1.

The outcome of the unsuccessful braking scenario was varied in the present studies: passing a line or running over and killing a child. We assume that negative affect is stronger when the outcome is running over a child than passing a line. This was tested by Svenson, Eriksson and Gonzalez (2012) in a study of how much affect was elicited by different versions of the braking and collision problem scenario. The affect scale they used consisted of 12 items. Most of the items were taken from different scales for measuring affect and emotion (Lubin and Van Whitlock, 2002; Lambie and Marcel, 2002; Watsen, Clark & Tellegen, 1988). The items were *sad, upsetting, exciting, scary, awful, shameful, gloomy, contemptuous, guilty.* Three items, *despising, repugnant* and *tense* were added to the set completing the scale of 12 items. The subjects were asked to indicate how well the different characteristics described the affective/emotional aspects of the scenarios on a scale from 1 (not at all) to 7 (exactly). The instruction included the following. "Think about the scenarios you have just read. To what extent are the scenarios characterized by the following adjectives?"

For half of the subjects, a child was run over as a consequence of the unsuccessful braking from the higher speed in the scenarios. The other half of the subjects judged the same scenarios but no child was involved; instead the outcome of the unsuccessful braking was simply pass-

[1] The money illusion was discussed as early as in 1930 by Fisher (1930) and has been defined in different ways that include, e.g., inflation and expressions of the same monetary value in different ways. Shafir, Diamond and Kahneman (1997) defines it in terms of a bias in the assessment of real value induced by nominal representations of equally valued assets.

Figure 1: Speed (kph) as a function of distance (m) from the location of a car when a driver becomes aware of an obstacle and starts braking. The different curves describe initial speeds from 30 kph to 110 kph for a driver-car reaction time of 1 sec with the friction coefficient between tires and road surface, $\mu = 0.8$.



ing a marking. The responses to the items of the affect scale were coded so that higher numbers indicated greater affect/emotion. Cronbach's alpha for the 12 item scale was 0.91. The results indicated that a significantly higher negative affect/emotion was elicited by the child scenario compared to the scenario with no such outcome $F(1,85) = 38.01$, $p < 0.000$ (Svenson, Eriksson & Gonzalez, 2012).

We hypothesized that the effect of negative affect would lead to higher judgments of collision speeds. This hypothesis was based on the assumption that a risk affect reaction will be triggered in the child scenario. The affect heuristic (Slovic, Finucane, Peters & McGregor, 2004) means that people react positively or negatively to all aspects of an event or an object via an affective reaction. This has been demonstrated by subjective judgments of risky events in which the probabilities as well as the consequences are affected by negative affect (Slovic, Monahan, & MacGregor, 2000; Rottenstreich & Hsee, 2001). Subjects in the present study should react with a strong negative affect to the consequence of hitting a child, and accordingly this leads to a more negative judgment of speed. A more negative judgment of speed means a higher collision speed and this applies to the child scenario to a greater extent than to the line scenario. This leads to higher collision speed judgments for the child condition compared to the line scenario.

We also varied who drove the car in the scenario, the subject herself or a driver in general. In particular, we asked whether subjects imagining themselves as drivers would underestimate the speeds in the same way as subjects who judge a braking episode of another driver in general.

The hypothesis was that when a subject imagines heror himself to be the driver, the response will reflect the "we are all more safe and more skilled drivers" effect (Svenson, 1981), which leads to overestimation of one's own ability to brake fast for both the collision and passing line scenarios.

This effect belongs to a class of self-serving biases described in the following way. "When people are asked to evaluate their own abilities, the assessments they provide tend to be self-serving. Indeed, often the appraisals that people endorse appear to be favorable to a logically impossible degree" (Dunning, Meyerowitz & Holzberg, 2002, p. 324). Thus, the present hypothesis predicts that the speed judgments should be lower for "the subject as driver" scenarios compared to "driver in general" scenarios. From an applied perspective, such judgments would underestimate the negative effects of driving fast and indicate that a respondent thinks that she or he can bring down speed faster than other drivers.

To summarize, in Study 1 we wanted to ask whether the European study where subjects underestimated braking speed could be replicated and whether a magnitude number effect could be found. In the earlier studies, university psychology students served as subjects and therefore we used this category of subjects in Study 1. (In Study 2 the subjects were sampled from the general public in an attempt to generalize the earlier findings.) We also wanted to test the hypothesis that the underestimation of collision speed found among drivers using the kph speed scale also applies to judgments made by drivers using mph speed measures. Third, we wanted to test whether the greater affective reaction to the collision scenario where a child is killed leads to higher or lower speed judgments than the line scenario if there was a difference. Furthermore, we tested the hypothesis that, when a subject her- or himself drives the car in the scenario, the judged ability to brake fast will be greater than when any other driver drives the car. This hypothesis predicts that the judged speeds will be lower when a subject her- or himself drives than when a driver in general is behind the wheel.

2 Study 1

2.1 Method

Subjects. A total of 88 persons associated with the University of California Berkeley participated in the study, 86 of whom had a driver's license. In all, 68 of the subjects were students of UC Berkeley and the remaining 20 were faculty and staff. A total of 82 reported to be American citizens. There were 55 (62%) female and 33 (38%) male subjects aged from 18 to 64 years with a mean age of 24.8 years (SD 10.6). The students signed up for the study through The Research Participant Program of UC Berkeley, Department of Psychology, and received mandatory credits for participating. The remaining subjects participated out of benevolence.

Procedure. The questionnaire was introduced to the subjects as a set of problems about braking from different speeds. The subjects were asked to make intuitive judgments rather than formal calculations. In addition, the subjects were asked about sex, age, years of having a driver's license, miles of driving per week and year, number of speeding violations, and if involved in any car accidents. These variables will be analyzed in a later study. The problems were solved in a classroom session, and, although the subjects could take the time they needed, they used approximately 15 minutes for writing down their personal data and solving the braking problems.

Material. Similarly to the earlier studies by Svenson, Eriksson and Gonzalez (2012), the subjects were given a scenario with two different situations concerning braking from different speeds. The first situation described a successful braking effort at a lower speed and, in the second situation, due to a much higher initial speed, a collision following an insufficient braking episode was described and the subjects were asked to estimate the speed at impact. The instruction included the following:

> With higher driving speed the stopping distance increases. Imagine a car driving at a test track with a speed of 18 mph and that the driver at a given signal is supposed to stop the car immediately. The driver is alert and starts to brake maximally with a reaction time of 1 second, the street is dry with good friction and the car is able to stop just in front of a white line painted across the track.
>
> Now imagine the same scenario, only this time the car is driving at 25 mph. The reaction time and conditions are the same as before, however, as the speed increases so does the stopping distance, therefore the driver will not be able to stop before the line.
>
> Please estimate at what speed the car will pass the line.

There were a total of 8 similar cases with different lower and higher speeds listed in Table 1. The speeds of the cases were the same as in the earlier European studies (Svenson, Eriksson, & Gonzalez, 2012) only converted to mph. The subjects were asked to judge the speed of the car in the second situation when it passed the point where the car with lower speed was able to come to a complete stop. The instructions to this task were divided into four different stimulus conditions in a factorial design. The conditions were the scenarios with subjects making judgments based on imagining themselves driving or a driver in general driving, combined with the passing of a line or running over and killing a child.

Thus, about one fourth of the subjects judged the speed of a car driven by a driver in general when passing a line (21 subjects), while one fourth were asked to judge the speed of a car driven by a driver in general when running over and killing a child (22 subjects). In the third condition, subjects were asked to judge their own speed when passing a line (22 subjects), and the subjects in the last group were asked to judge their speed when running over and killing a child (23 subjects).

2.2 Results

First, the differences between subjects' estimated speeds (all four stimuli combinations included) were tested against the correct new speeds. Table 1 gives the lower and higher speeds, the average estimated speeds for all conditions, and the correct speeds at collision according to Equation 1 and 2. Each one of the judged collision speeds were systematically underestimated. These results are in congruence with Svenson's (2009) and Svenson, Eriksson and Gonzalez' (2012) findings and show that these results also apply to braking when speed is given and judged in mph. When the speeds judged in mph were compared with the same physical speeds in kph (Svenson, Eriksson, & Gonzalez, 2012) the mph judgments were all higher than the Swedish judgments as illustrated in Table 2, but the effect was significant only for increases from the lowest initial speeds, 18 mph or 30 kph.

To test whether different stimulus conditions would influence judgments, they were tested against each other

Table 1: Estimated new speed (mph) after braking from a higher speed (where car with lower speed had come to a stand still after the same braking pattern for both cars) in Study 1.

Case	Lower speed	Higher speed	Estimated speed	Physical speed	Difference	t-value and significance
1	18	25	11.69 (7.8)	23.38	−11.69	−13.6***
2	25	40	20.13 (8.7)	38.75	−18.62	−19.9***
3	37	81	45.02 (15.7)	81.00	−35.98	−21.4***
4	31	44	18.73 (11.4)	37.83	−19.10	−15.7***
5	50	75	34.15 (19.5)	63.27	−29.12	−14.0***
6	18	31	15.51 (6.3)	31.00	−15.49	−22.9***
7	25	50	26.35 (10.3)	50.00	−23.65	−21.5***
8	25	31	12.68 (9.1)	23.38	−10.70	−11.1***

Note: All entries in the table are expressed in mph. Standard deviations in parentheses. The physical speed is the correct new speed predicted by equation 1 and 2. Difference gives the difference between estimated new speed and physical correct new speed.

*** $p < 0.001$ two-tailed tests.

Table 2: Mean and variance of the mean for U.S. and Swedish sample. Computed pooled variance for both samples in Study 1.

Case	Lower speed	Higher speed	Physical speed	Mean U.S.	Variance mean	Mean Swedish	Variance mean	Pooled variance	t-value
1	30 (18)	40 (25)	35.6 (23.4)	18.8 (11.7)	1.84	14.6 (9.1)	1.51	1.70	3.21**
3	60 (37)	130 (81)	130.0 (81.0)	72.4 (45.0)	7.18	71.6 (44.5)	12.67	9.42	0.26 ns
4	50 (31)	70 (44)	59.4 (37.8)	30.1 (18.7)	3.84	29.8 (18.5)	4.45	4.09	0.15 ns
5	80 (50)	120 (75)	101.3 (63.3)	59.9 (37.2)	11.22	56.8 (35.3)	11.90	11.5	0.91 ns
6	30 (18)	50 (31)	50.0 (31.0)	24.9 (15.5)	1.17	21.0 (13.1)	1.79	1.42	3.28**

Note: All entries in the table are expressed in kph. Mph in parentheses. Only 5 of the total of 8 cases in Table 1 were identical with the cases from the Swedish study, thus were eligible for comparison.

** $p < 0.01$ two-tailed.

with *t*-tests. Table 3 shows estimated new speeds for subjects' judgments for the four conditions and the difference in means between line/child scenario and between yourself/driver in general scenario. The child scenario gave higher average judgments of speed in all cases, although only statistically significant in case 1. When the main actor was a driver in general, the average judgments in all eight cases were higher compared to when the driver was the subject her- or himself. However, the difference was not statistically significant in any of the cases.

A three-way mixed ANOVA was performed to further investigate the relationship between the different instructions and judgments. The first factor was the within-subjects factor of cases with eight levels. The second factor was the between-subjects instruction of driver, with two levels: yourself and a driver in general. The third factor was the between-subjects instruction of obstacle, with two levels: crossing a line and running over and killing a child. None of the you/driver and line/child factors was statistically significant in this sample of psychology students. It is clear that the child and driver scenarios on average gave systematically higher average judged speeds of collision. Therefore, this will be the hypothesis to be tested in the following study using subjects of a general public sample.

To summarize, (1) the European results were replicated with mph measures, (2) when the subject was the driver the judged speeds tended to be lower and (3) when a child was killed the judged speed tended to be higher. The last two tentative findings were used as hypotheses in the following study.

Table 3: Estimated new means for braking distances divided by passing a line and hitting a child instructions and by subjects self driving and driver in general instructions in Study 1.

Case	Mean line	Mean child	Mean difference	t-value	Mean you	Mean driver	Mean difference	t-value
1	9.61 (6.5)	13.60 (8.4)	−3.99	.016*	11.52 (8.7)	11.88 (6.8)	−0.36	.832
2	18.35 (9.1)	21.84 (8.2)	−3.50	.062	18.60 (8.3)	21.74 (9.1)	−3.14	.094
3	43.30 (15.7)	46.67 (15.9)	−3.36	.320	44.11 (13.5)	45.98 (18.0)	−1.87	.585
4	16.74 (11.5)	20.64 (11.2)	−3.90	.110	17.36 (10.9)	20.19 (11.9)	−2.83	.248
5	31.42 (18.9)	36.78 (19.9)	−5.36	.199	32.40 (19.1)	36.00 (20.1)	−3.60	.391
6	14.60 (6.8)	16.38 (5.8)	−1.77	.194	14.67 (6.1)	16.39 (6.6)	−1.73	.204
7	26.00 (11.9)	26.70 (8.5)	−0.70	.752	25.82 (9.9)	29.93 (10.8)	−1.11	.619
8	11.14 (8.5)	14.16 (9.5)	−3.02	.118	11.38 (8.7)	14.05 (9.3)	−2.67	.169

Note: All entries in the table are expressed in mph. Standard deviations in parentheses. Mean difference gives the difference between the means from the two instructions being compared.

* $p < 0.05$ two tailed.

3 Study 2

3.1 Method

Subjects. The subjects were recruited from the web panel of Decision Research in Eugene, Oregon. The members of the panel come from all parts of the U.S.. When recruiting for the present study, an email was sent to potential subjects inviting them to participate. A total of 352 subjects accepted the invitation and the mean age of the subjects was 42.5 years and there were 182 women (52%) and 170 (48%) men all over 18 years old. They were each paid $1.50 for their time and effort.

Procedure. To take part in the study, a panel member could simply click on a link to the study in the email. The median time spent on doing the survey was 4.5 min. Following the instruction, the problems were presented one at a time with no possibility to go back to a previous problem once the answer had been given to a problem. When a subject had answered a problem, the next problem was presented automatically.

Material. Subjects were given the same scenarios as in Study 1, they would either pass a line or hit a child at the higher speed and it would either be the subjects themselves driving or a driver in general. The cases were also the same as in the first study. The design was factorial with an actor (subject as driver/driver in general) x outcome (child/line) setup. The subjects were randomly distributed over these four different combinations.

3.2 Results

Two subjects did not respond to two or more problems and another 21 subjects gave two or more speed judgments exceeding the greater speed, which is physically impossible. Both these categories of subjects were excluded leaving 329 subjects for the data analysis. Table 4 shows the average judged braking speeds for different problems across all conditions. A comparison with the physically correct speeds in the table shows that braking speed was overestimated. This replicates earlier findings of overly optimistic views of how fast the speed of a faster car can be reduced compared to braking from a lower speed (Svenson, 2009; Svenson, Eriksson & Gonzalez, 2012).

When the data were divided according to actor and outcome factors, the pattern in Table 5 emerged. The child scenarios gave collision speed judgments that were on average 6.36 mph (30.87–24.51) higher than those for the line judgments. The actor or driver factor gave collision speed judgments that were 2.07 (28.90–26.83) mph higher for the driver in general scenarios. Table 5 gives individual t-tests for the different scenarios and in order to assess the overall effects we used a three-way ANOVA (line/child x you/driver x problem) with repeated measures on the third factor which gave the following result. The line/child factor resulted in a significant result $F(1/310) = 28.79$, $p \leq 0.0001$, and the driver factor was also significant $F(1/310) = 6.91$, $p \leq 0.009$. There was no significant interaction between these factors.

Table 4: Average judged speeds and physical speeds when car brakes from higher speed and passes the stopping point from lower speed (mph) in Study 2.

Lower speed	Higher speed	Mean judged speed	Physical speed	Difference	t-value
18	25	14.46 (8.0)	23.38	−8.92	−19.7***
25	40	23.59 (10.3	38.75	−15.16	−26.7***
37	81	50.64 (17.5)	81.0	−30.36	−31.4***
31	44	24.80 (13.5)	37.83	−13.03	−17.5***
50	75	44.37 (21.3)	63.27	−18.90	−16.0***
18	31	18.56 (8.0)	31.00	−12.44	−28.2***
25	50	30.08 (10.8)	50.00	−19.92	−33.5***
25	31	17.40 (10.6)	23.38	−5.98	−10.2***

*** p<0.001 two tailed tests

4 Discussion

The present investigation showed that formally identical hypothetical scenarios only differing in how the actor and outcome were described lead to significantly different speed judgments.

The main finding was that judgments in all conditions underestimated the remaining speed after braking at a higher speed compared to a lower speed. To illustrate, the average judged speed over the 8 problems in Study 2 ranged from 24.51 to 30.87 mph while the correct average was 43.57 mph. Hence, the underestimation of collision speed after braking is strong and robust across conditions and across different units of speed measure. This means that people have an overly optimistic view of being able to reduce speed in time when speeding and something unexpected appears on the road. All problems assumed close to perfect road conditions with a friction coefficient, μ = 0.8. If the conditions had been worse like on a rainy day, the friction would have been lower with μ = 0.4. In this case the physical braking speeds would have decreased somewhat. To illustrate, speeding and braking at 40 mph with a speed limit of 25 mph changes the objective braking speed from 38.8 to 35.2 mph and braking at 75 mph with a speed limit of 50 mph changes the objective braking speed from 63.3 to 59.7 mph. The judged braking speeds in these cases were 23.59 and 44.37 mph (Table 4) significantly below the correct speeds even for poor weather conditions. Faster driver-vehicle reaction time than 1 sec is not realistic in a situation with an unexpected suddenly appearing obstacle. The standard deviations of the speed judgments indicate that, although the averages were far off the correct values, a minority (between about 4 and 20%) of the judgments were reasonably close to the correct values. Therefore, it will be interesting to investigate individual performance differences in future studies.

In some scenarios, the actor was the subject her- or himself as opposed to a driver in general and the outcome of the unsuccessful braking episode was either colliding with and killing a child or crossing a line. The strong affect child scenarios generated collision speed judgments that were higher and somewhat closer to the correct braking speeds than scenarios without strong affect. This supports the hypothesis that negative affect leads to worse outcome judgments (higher speed). In scenarios where the subject imagined her- or himself to be the driver the speed judgments were lower and further away from the correct values than when a driver in general was driving, which supports the "we are all better drivers" hypothesis. However, as mentioned above, all average judgments of collision speeds for the different conditions were significantly smaller than the correct values. This result illustrates general unjustified optimism concerning how fast a speeding car can be slowed down in response to an unexpected hazard.

The present research is relevant to debates of speed limits and attitudes to speed limit and speed limit compliance (Aarts & van Schagen, 2006; Cameron & Elvik, 2010; McCloy, Byrne & Johnson-Laird, 2010). Drivers need to make accurate judgments of stopping distances in order to appreciate the safe distance to the car in front or risk of a higher speed. It also deals with intuitive judg-

Table 5: Average judged speeds and physical speeds when car brakes from higher speed and passes the stopping point from lower speed (mph) for line- child and you-driver conditions. The correct average braking speed across the 8 problems was 43.57 mph in Study 2.

Low speed	High speed	Line N=151	Child N=178	Difference	You N=150	Driver N=179	Difference
18	25	12.87 (8.9)	15.80 (6.9)	−2.93***	13.49 (7.6)	15.27 (8.3)	−1.78*
25	40	20.50 (10.8)	26.22 (9.1)	−5.72****	22.92 (9.8)	24.15 (10.7)	−1.23
37	81	46.19 (18.0)	54.37 (16.2)	−8.18****	49.34 (17.5)	51.73 (17.5)	−2.39
31	44	20.27 (13.3)	28.65 (12.5)	−8.38****	23.64 (13.8)	25.79 (13.8)	−2.15
50	75	38.47 (21,5)	49.42 (19.9)	−10.95****	42.12 (21.6)	46.27 (21.6)	−4.15
18	31	16.21 (8.0)	20.55 (7.5)	−4.34****	17.45 (7.9)	19.48 (8.1)	−2.03*
25	50	27.21 (11.5)	32.53 (9.5)	−5.32****	29.63 (10.3)	30.45 (11.2)	−0.82
25	31	14.73 (10.9)	19.65 (9.9)	−4.92****	16.10 (10.4)	18.49 (10.8)	−2.39*
	Mean	*24.51*	*30.87*		*26.83*	*28.90*	

* p<0.05, *** p<0.001 two tailed tests.

ments which policy makers, drivers and the general public often rely on when forming their opinions about speed limits. A strong bias in these judgments can affect attitudes and opinions, which is especially unfortunate if it leads policy makers to make decisions which are not based on correct information or drivers underestimating the risk of a higher speed. Future studies need to investigate how we can teach people to make more accurate judgments of this kind.

Even though the problem of estimating how fast a car can slow down when braking from a higher speed compared to a lower speed is quite a demanding task (Svenson, 2009), there is no reason from rational or internal judgment consistency perspectives to assume *a priori* that the use of the information in a scenario should differ if the numerical information and the physical conditions are the same across different problems scenarios. The present results exemplify how context effects can influence judgments without a normative basis (Hershey, Kunreuther & Shoemaker, 1988) and that judgments may be inconsistent as a result of variations in actor and outcome contexts. Much previous judgment and decision research has either assumed context invariance or explored different framings in terms of the verbal labels of the same number problem as in the Asian disease problem. However, it seems also important for judgment and decision researchers to study further the influence on human judgment and decision making of scenario outcomes and actor/observer differences.

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