Reports

Same numbers, different meanings: How numeracy influences the importance of numbers for pro-social behavior

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HIGHLIGHTS

► We examine the effects of numeracy on pro-social behavior.
► In three studies we varied numerical cues in donation requests.
► Higher numeracy increases proportion dominance in donation decisions.
► Effectiveness mediates the effect of proportion on donations for high numerate individuals.

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ABSTRACT

Numerical information often serves as a basis for evaluations, decisions and behavior. In requests for charitable giving, three numerical cues in the donation description are of particular importance: the number of potential recipients of a donation, the total number of people in need, and their proportion. In three studies, we examined the effects of numeracy on the weight given to these numerical cues in donations. Study 1 contrasted the importance of a higher absolute number (of potential recipients and the number of people in need) vs. a higher proportion of recipients. In Study 2, we investigated the effects of the total number of people in need and Study 3 was designed to focus on the impact of the absolute number of potential recipients. Our results revealed a consistent pattern demonstrating that highly numerate individuals were willing to donate more for projects that offered assistance to the greatest proportion of recipients. Conversely, less numerate individuals were insensitive to this proportion; they tended to donate more with increases in both the number of recipients and the total number of people in need. The meaning of numbers in donation decisions and the resulting motivation to help depends on numeric skill.

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Introduction

People are often confronted with numerical information in a variety of situations and presumably incorporate it into their evaluations and decisions. Pro-social decisions that take the form of charitable gifts are no exception. News and humanitarian-aid organizations use numerical information to signal critical needs. A charity, for example, may solicit donations while portraying the suffering of others through numbers. Media coverage informs us about the millions of HIV-affected Africans or the thousands of homeless Japanese after the 2011 tsunami. Particularly donation projects also inform about the number of recipients one can reach with a donation. The importance of different numerical cues for donation decisions has been demonstrated in previous research and has focused on three cues: the number of potential donation recipients, the number of people in need (usually considered the reference group), and the proportion between them (e.g., Bartels, 2006; Fetherstonhaugh, Slovic, Johnson, & Friedrich, 1997).

The effects of numerical cues on donations are not as straightforward as one might assume. For example, if lives are valued equally (as would be expected within most modern value systems; Dickert & Slovic, 2011), the relationship between the number of potential recipients and donation amounts should be linear. Research has shown, however, that people discriminate more between smaller numbers of victims, but are not as sensitive to changes when the numbers become large (Slovic, 2007). Moreover, single identified victims often receive more help than groups of victims (Kogut & Ritov, 2005a,b, 2007; but see Kogut, 2011). Also, one might assume that evaluations...
of potential recipients should be independent of the reference-group size. Conversely, research has demonstrated that, without a reference point, numbers are notoriously difficult to evaluate (Hsee, 1996; Hsee & Rottenstreich, 2004; Hsee & Zhang, 2010; Slovic, Finucane, Peters, & MacGregor, 2002).

In fact, although a large reference group indicates a large humanitarian crisis, helping a specific number of victims from a smaller reference group is often evaluated more positively than helping the same number of victims from a larger reference group (Baron, 1997; Jenni & Loewenstein, 1997). Accordingly, the proportion of victims who can be helped in a reference group is an important criterion in donations (i.e., proportion dominance; Bartels, 2006; Bartels & Burnett, 2011; Fetherstonhaugh et al., 1997; Friedrich et al., 1999; Friedrich & Dood, 2009).

**Influence of numeracy in decision making**

A prerequisite to understanding and using numbers is sufficient numerical skill (i.e., numeracy), defined as the ability to comprehend and apply numerical information. Numeracy most often focuses on frequencies, proportions, and percentages (Peters, 2012; Peters et al., 2006; Reyna, Nelson, Han, & Dieckmann, 2009; but see Peters, Baker, Dieckmann, Leon, & Collins, 2010; Weller et al., 2012). As literacy is the ability to read, write and understand written text, numeracy concerns comprehending, processing, and using numerical information appropriately (Keller, 2011; Keller & Siegrist, 2009; Lipkus, Samsa, & Rimer, 2001; Nelson, Reyna, Fagerlin, Lipkus, & Peters, 2008; Peters, 2008; Peters, Dieckmann, Dixon, Hibbard, & Mertz, 2007; Peters & Levin, 2008; Peters et al., 2005; Reyna et al., 2009). The rapidly expanding field of research on numeracy has documented that a lack of numeric skills often leads to uninformed and biased decisions. Numeracy is moderately related to proxies of intelligence (e.g., SAT scores); however, controlling for intelligence reduces but does not eliminate the effects of numeracy on various decisions (e.g., Liberali, Reyna, Furlan, Stein, & Pardo, 2012; Peters, Slovic, Västfjäll, & Mertz, 2008; Peters et al., 2006). Additionally, numeric knowledge can be destroyed by inferior-parietal lesions without impairing non-numerical knowledge (Dehaene, 1997).

Research has demonstrated that less numerate individuals tend to base evaluations more on non-numerical cues and are relatively insensitive to differences between numeric magnitudes. More numerate individuals, on the other hand, work more with numbers, derive meaningful information from them, and rely more on numbers in risk perceptions and decisions (Cokely & Kelley, 2009; Dieckmann, Slovic, & Peters, 2009; Peters, 2012). Numeracy differences influence the information available to decision makers and how that information is processed. Previous research suggests that affective reactions towards victims have similar effects on donation decisions for more and less numerate individuals (Dickert, Kleber, Peters, & Slovic, 2011), but numeracy may influence the focus on different information that is the source of those affective reactions (Peters, 2012).

In donation requests, we expected numeric information (i.e., the number of potential recipients, the reference group, and their proportion) to be weighted differently depending on numeracy. Thus, we extend previous research on pro-social decision-making and proportion dominance by including numeracy as a potential moderator. Donation decisions of less numerate individuals should be relatively insensitive to provided numerical information (e.g., Dieckmann et al., 2009; Peters, 2012). Nevertheless, they do not seem to ignore numerical information entirely. Previous research has shown that less numerate individuals process numbers in less depth, choosing, for example, based on numerators while neglecting denominators (Peters et al., 2006; Reyna & Brainerd, 2008). Similarly, in donation requests, less numerate individuals are also expected to demonstrate less complex number processing and to focus on more salient numbers. However, what number is salient to less numerate individuals might differ by decision context. In donation requests, it is less clear whether the number of potential recipients would be the most salient number or whether the reference group itself would be most salient as it might indicate the magnitude of the humanitarian crisis.

In contrast, more numerate individuals tend to use more complex numeric information. Specifically, they tend to compare numbers and transform given frequencies (the number of potential recipients and the reference group) into proportions (or at least into an equivalent magnitude difference). Compared to the less numerate, the highly numerate find proportional information easier to comprehend, draw meaning from, and weigh in decisions (Dieckmann et al., 2009; Peters, 2008; Peters et al., 2006; Reyna et al., 2009). The proportion is not necessarily the most critical cue in decisions, but it may be related to the project’s overall effectiveness. Valuing projects higher that offer greater proportional help (instead of valuing them based on the number of potential recipients or the reference group) may indicate that effectiveness considerations are important for the decision. Indeed, previous research found a stronger relation between donation decisions and effectiveness ratings among more numerate individuals (Dickert, Kleber, Peters, & Slovic, 2011). Therefore, we hypothesize that among highly numerate individuals effectiveness considerations and the underlying proportional helpful will weigh more in donation decisions.

**Overview of studies**

In the current research, we explored numeracy’s effects on the importance of numerical cues in donation requests. We hypothesized that proportional help will be more important to the highly numerate, whereas the number of potential recipients or the size of the reference group should be more important to the less numerate. In Study 1, numeracy differences in the tendency to help a greater number versus a greater proportion of victims were tested. In Study 2, we investigated the effects of reference-group size; Study 3 focused on the sensitivity to numbers of potential recipients. Throughout all three studies, we controlled for individual differences in affective reactions and general attitude towards donations given their importance in pro-social decisions (Batson, 1991; Dickert & Slovic, 2009; Graziano, Habashi, Sheese, & Tobin, 2007).

**Study 1**

**Method**

**Participants**

Eighty-three participants (M<sub>age</sub> = 24.5, SD<sub>age</sub> = 6.1; 53% women) took part in this study lasting approximately 25 min. Participants were recruited from the University of Bonn using a participant-administration system (Greiner, 2004) and were compensated with 12 Euros/h.

**Materials and design**

We presented participants with one of two humanitarian-aid projects — one that helped a greater proportion of people in need, whereas the other helped a greater absolute number (but smaller proportion) of potential recipients. Provided numerical information included the number of potential recipients and the reference group; the proportion was not displayed. In the first project, participants could donate to one starving child out of 10 children (labeled “Project 1/10”) and thus help 10% of the victims. The other project helped two starving children out of 50 (labeled “Project 2/50”, helping 4% of the victims).

We measured participants’ affective reactions towards the victims on scales from “don’t agree at all” (1) to “completely agree” (9). In particular and in line with previous work, we assessed participants’ sympathy, compassion, worry, sadness towards the victims, their anticipated regret if they did not donate, their perceived moral obligation to help, and how much better participants would feel if
they donated (see Dickert, Sagara, & Slovic, 2011; Kogut & Ritov, 2005a, 2005b).

In addition, we measured general attitude towards donations with three statements using the 9-point-agreement-scale above: “I believe that donations help to improve the lives of people in need”, “I would regularly donate, if I had enough money available”, and “I believe that, in general, donations are a meaningful way to help people in danger of starvation”.

We assessed participants’ numeracy using a 15-item questionnaire (Peters et al., 2007) that modified Lipkus et al.’s (2001) earlier scale with four difficult items for more educated participants. Due to our undergraduate sample, this measure was more appropriate. Comprehension of frequencies, probabilities, and percentages was tested within different contexts (e.g., medical decisions, gambling) with a mixture of open-answer and multiple-choice questions (e.g., “The chance of winning a car is 1 in 1000. What percent of tickets win a car?”). The resulting numeracy score reflected the sum of correct answers.

Procedure
Participants were tested individually and randomly assigned to one of the two project conditions. Each hypothetical project description included minor information to enhance the importance of the numerical cues (see Appendix A). Then, participants indicated their donation amount with an open-ended question (“How much are you willing to donate to this project”). Afterwards, affective reactions, donation attitude, and numeracy were measured.

Results

Preliminary data analysis
Donation amounts were positively skewed (z(g1) = 28.95, p < .001), winsorized (<3% of the data) and log-transformed (z(g1) = 0.28, p = .78). The affective-reaction items were combined into one scale (Cronbach’s α = .82). The items of the general attitude towards donations were also aggregated (Cronbach’s α = .90). Descriptive data are presented in Table 1. Numeracy ranged from 7 to 15 (item difficulty: 0.15 to 0.96 but four items with item difficulty of 1.00) and was skewed, z(g1) = 4.36, p < .001. However, the standardized residuals of the regression coefficients were not skewed, z(g1) = 0.88, p = .38 and acceptable tolerances of the regression were ensured by mean-centering numeracy (max. VIF = 1.84).

Donation amounts
We conducted a linear regression with numeracy, contrast-coded project type, their interaction, donation attitudes, and affective reactions as predictors. This model significantly predicted donation amounts,1 F(5, 77) = 18.32, p < .001, R² = .54. As expected, more positive general attitudes towards donations, β = .26, t(77) = 2.52, p = .01, and stronger affective reactions, β = .53, t(77) = 5.08, p < .001, were related to higher donations.2 A main effect of project, β = .18, t(77) = 2.25, p = .03, demonstrated higher donation amounts for Project 2/50 than for Project 1/10, whereas numeracy’s main effect was not significant, β = −.11, t(77) = 1.44, p = .16. Importantly, the interaction significantly predicted donation amounts, β = −.21, t(77) = 2.66, p < .01 (see Fig. 1). Simple slope analyses (Hayes & Matthes, 2009) demonstrated that the difference between projects was significant for less numerate individuals (1 SD below the mean), β = .40, t(77) = 3.50, p < .001. Donations of individuals with higher

1 In all studies, a highly skewed distribution of the regression residuals (z(g1) > 6.50, p < .001) prohibited regressions to predict untransformed donation amounts (Allan & West, 1991). Nevertheless, using untransformed donations revealed a similar pattern of results in all studies.

2 Including the interactions of the covariates with numeracy did not improve the model (ΔF = 1) and revealed no significant interactions, |t|s < .16, ts < 1.08, ps > .28.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Donation (winz)</td>
<td>26.89</td>
<td>43.09</td>
<td>56.13</td>
</tr>
<tr>
<td>Donation (ln)</td>
<td>2.07</td>
<td>1.77</td>
<td>3.31</td>
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<tr>
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<td>1.57</td>
<td>11.16</td>
</tr>
<tr>
<td>Affect</td>
<td>5.78</td>
<td>1.51</td>
<td>6.27</td>
</tr>
<tr>
<td>Attitude</td>
<td>6.13</td>
<td>2.05</td>
<td>6.27</td>
</tr>
</tbody>
</table>

Note. Donation (winz) = winsorised donations (Study 1 and Study 2 at 200 Euro, Study 3 at 500 Euro); Donation (ln) = log transformation of winsorized donations.

Discussion

As hypothesized, we found that the effects of offering greater absolute help versus more proportional help depended on numeracy. Less numerate participants donated more for the project with more potential recipients and a higher reference group; thus, we have evidence of number sensitivity among the less numerate. The manipulation did not influence donations among more numerate individuals. It might be that the small difference in proportional help in these projects (4% vs. 10% help) was deemed equally helpful (or unhelpful) by them.

Study 2

In Study 2, we varied proportional help between the projects to a greater extent by manipulating the reference-group size while holding constant the number of potential recipients. Less numerate individuals might increase donations with exposure to a larger reference group or they might be insensitive to reference-group differences, which would suggest that their donation decisions in Study 1 were driven by the number of potential recipients. Using greater differences in proportions, we expected donations among more numerate individuals to increase in response to the smaller reference group (and greater proportional help).

Method

Participants, materials, and design
University of Vienna undergraduates (N = 155; Mage = 23.6, SDage = 5.4; 73% women) participated in this experiment and were compensated with 6 Euros/h.

The donation requests were similar to Study 1 and depicted children in danger of starvation with a constant number of potential recipients (i.e., 5 children) and a varying reference-group size: small (10 children), large (1000 children) or no reference group (control condition).

Procedure
Participants were tested individually and assigned randomly to one of three reference-group conditions. To manipulate reference-group size, we expected donations among more numerate individuals to increase in response to the smaller reference group (and greater proportional help).

Results

Preliminary data analysis
Donation amounts were positively skewed (z(g1) = 42.81, p < .001), winsorized (<7% of the data) and log-transformed (z(g1) = 2.43,
Donation amounts (ln) by project and numeracy (low = 10.81; high = 13.94).

\[ \beta = .12, p = .02 \]

The affect scales and donation attitudes were combined as in Study 1 with comparable reliabilities (Cronbach’s α = .84 and Cronbach’s α = .76, respectively). Numeracy ranged from 5 to 15 (item difficulties: 0.19 to 0.94) and was skewed, z(\(g_1\)) = 2.40, p = .02.

For the regression analysis, a test of biased standard errors revealed that the standardized residuals were not significantly skewed, z(\(g_1\)) = 1.88, p = .06. Numeracy was mean-centered to ensure acceptable tolerances (max. VIF = 1.45). The reference-group manipulation was included as two Helmert contrast-coded dummies to examine whether the addition of a reference group influenced donations (D1: reference group 10 = +1, reference group 1000 = +1, control group = 0).

Table 2

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numeracy</td>
<td>−.12</td>
<td>1.57</td>
<td>.12</td>
</tr>
<tr>
<td>D1</td>
<td>−.01</td>
<td>0.06</td>
<td>.95</td>
</tr>
<tr>
<td>D2</td>
<td>−.01</td>
<td>0.14</td>
<td>.89</td>
</tr>
<tr>
<td>Numeracy × D1</td>
<td>−.01</td>
<td>0.11</td>
<td>.91</td>
</tr>
<tr>
<td>Numeracy × D2</td>
<td>−.18</td>
<td>2.49</td>
<td>.01</td>
</tr>
<tr>
<td>Affect</td>
<td>.35</td>
<td>4.25</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Attitude</td>
<td>.15</td>
<td>1.77</td>
<td>.08</td>
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</tbody>
</table>

Note. D1 = Dummy contrasting the reference group conditions with the control group; D2 = Dummy contrasting the reference groups 10 and 1000.

**Study 3**

The purpose of Study 3 was to examine how individuals differing in numeracy react to different numbers of potential donation recipients while holding the reference-group size constant. In Study 1, less numerate individuals donated more to projects with more potential recipients and a larger reference group, whereas changes in the reference group alone had a small, non-significant effect in Study 2. Study 3 was intended to uncover whether an increase in the number of potential recipients influences donations of less numerate individuals.

In Study 2, higher numeracy was related to greater sensitivity to proportional help. Study 3 was also designed to replicate this effect and to obtain more insight into the psychological mechanisms underlying donation decisions of more numerate individuals. Thus, we examined the estimated effectiveness of projects. We expected that, for highly numerate individuals, effectiveness ratings would increase with increasing proportions of victims being helped and that perceived effectiveness would be more important for their donation decisions compared to the less numerate.

**Method**

One-hundred fifty-one University of Vienna undergraduates (Mage = 24.3, SDage = 4.5; 76% women) completed this study to fulfill course requirements. In a between-subjects design, we manipulated the number and proportion of potential recipients, keeping the reference group constant (i.e., 120 children). Participants saw one of four levels of potential recipients: 6 out of 120 children (95% help), 60 out of 120 children (50% help), 114 out of 120 children (95% help), and all 120 children (100% help).

**Participants and design**

One-hundred fifty-one University of Vienna undergraduates (Mage = 24.3, SDage = 4.5; 76% women) completed this study to fulfill course requirements. In a between-subjects design, we manipulated the number and proportion of potential recipients, keeping the reference group constant (i.e., 120 children). Participants saw one of four levels of potential recipients: 6 out of 120 children (95% help), 60 out of 120 children (50% help), 114 out of 120 children (95% help), and all 120 children (100% help).

**Discussion**

Study 2 demonstrated that the reference-group size is an important cue in donation decisions, but how it is used depends on numeracy. The results suggest that those higher in numeracy considered the proportion and donated more to the project with higher proportional help (and smaller reference group), whereas donations of less numerate individuals are not significantly influenced by the reference group.

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3 Including the interactions of numeracy and the covariates did not improve the model, \( \Delta F(2, 145) = 2.15, p = .12, \Delta R^2 = .02 \) and showed no significant interactions, |β| < .12, ts < 1.53, ps > .13.
Materials and procedure

Materials and procedure were similar to our previous studies. In the donation request, the proportions of 5%, 50% and 95% of help were manipulated with “Your donation would be used for a specific region in Africa to help 6 vs. 60 vs. 114 children out of 120 affected children”. To induce 100% help, we used the statement “Your donation would be used for a specific region in Africa to help all of the 120 affected children”. Next, the donation amount, estimated effectiveness of the project (i.e., “How effective is this project”), affective reactions, general donation attitude, and numeracy were assessed. We used the same questionnaires as in Study 1 and 2 with the addition of the effectiveness rating.

Results

Preliminary data analysis

As before, donation amounts were positively skewed (z(g1) = 23.83, p < .001), winsorized (<5% of participants), and log-transformed (z(g1) = 4.27, p < .001). The scales exhibited good reliabilities (affective reactions: Cronbach’s α = .83; donation attitudes: Cronbach’s α = .80). Numeracy was skewed, z(g1) = 5.17, p < .001 and ranged from 2 to 15 (item difficulties: 0.19 to 0.97). However, the skewness of numeracy did not bias the standard errors of the regression as indicated by the not significant skewness of the standardized residuals, z(g1) = 1.45, p = .15. To ensure acceptable tolerances in the regression, numeracy was mean-centered (max. VIF = 1.54).

Donation amounts

Donation amounts were significantly predicted by numeracy, the linear contrast of the proportion manipulation (i.e., 5% = −1.5, 50% = −0.5, 95% = +0.5, 100% = +1.5), their interaction, affective reactions, and general donation attitudes,4 F(5, 145) = 6.09, p < .001, R² = .17. As in previous studies, stronger affective reactions were related to higher donation amounts, β = .29, t(145) = 3.18, p < .01. The effect of attitude did not approach statistical significance, β = .01, p > .99. Furthermore, donation amounts increased with decreasing numeracy, β = −.16, t(145) = 2.08, p = .04, and increasing proportions of victims helped, β = .14, t(145) = 1.91, p = .06 (linear trend). Although the interaction between numeracy and the linear contrast did not reach significance at a 5% level, β = .14, t(145) = 1.83, p = .07, simple slope analyses showed that, among highly numerate individuals, donation amounts increased as the proportion increased, β = .19, t(145) = 2.63, p = .01, whereas no linear trend existed among the less numerate, β = .01, t(145) = 0.08, p = .93 (see Fig. 3). Thus, donations increased with increasing proportions of victims helped only among highly numerate individuals.

Effectiveness ratings

We hypothesized more numerate individuals to perceive projects with increasing proportions of victims helped as more effective. Effectiveness ratings were regressed on numeracy, the linear contrast, and their interaction. As illustrated in Fig. 4, the ratings were significantly predicted by the linear contrast of the proportion manipulation and the interaction between the contrast and numeracy, F(3, 147) = 7.84, p < .001, R² = .14. In particular, effectiveness ratings increased with increasing proportions, β = .31, t(147) = 3.98, p < .001. Additionally, the significant interaction with numeracy, β = .21, t(147) = 2.79, p = .01, indicated a stronger relation among highly numerate individuals, β = .23, t(147) = 4.77, p < .001 than among the less numerate, β = .05, t(147) = 0.97, p = .34. Numeracy’s main effect did not approach statistical significance, β = .04, t(147) = 0.52, p = .60.

Furthermore, we expected more numerate individuals to show a stronger effect of proportions on effectiveness ratings and a stronger relationship between effectiveness and donations. Therefore, we conducted a moderated mediation [see Fig. 4] to test numeracy’s effect on both paths simultaneously (i.e., Model 5 in Preacher, Rucker, & Hayes, 2007). As predicted, the indirect effect reached significance for more numerate individuals, β = .07, Z = 2.31, p = .02, 95%-CI [0.003, 0.175], but not among the less numerate, β < .01, Z = 0.09, p = .93, 95%-CI [−0.012, 0.025]. Therefore, among more numerate individuals, the proportion manipulation had a stronger influence on effectiveness ratings and the effectiveness ratings were more important in their donation decisions.

Discussion

The results of Study 3 demonstrated that an increase in potential donation recipients (e.g., from 6 to 120 and thus, from 5% to 100% of victims helped) was associated with greater donations only among more numerate individuals, whereas those with lower numeracy were insensitive to the number of potential recipients. The moderated mediation and the strong relationship between effectiveness ratings and donation amounts for more numerate individuals further demonstrated the relevance of donation effectiveness for them.

General discussion

In three studies, we examined the effect of numeracy on the importance of numerical cues to donation decisions. In Study 1, we contrasted more absolute help against a higher proportional help. In Study 2, the reference-group size was varied, and, in Study 3, different numbers of potential recipients (and proportions) were investigated. The overall pattern of results showed that the importance and meaning of numerical cues in donation decisions depend on donors’ numeracy. In fact, only through the interactions with individual difference in numeracy can the effect of the varying numbers in the donation requests be understood.

Less numerate individuals were willing to donate more when the number of recipients and the reference-group size increased (Study 1). The effect of increases in the reference group by itself was inconclusive among less numerate individuals (i.e., non-significantly higher donations for a larger reference group; Study 2) and their donation decisions were insensitive to the proportion and number of potential victims helped (Study 3). Accordingly, it might be the combination of a higher number of recipients and a larger reference group that is necessary to increase donations among less numerate individuals. It could also be possible that the specific numbers in the donation requests influence the pattern of results. For example, the effect of the number of recipients for the less numerate might be limited to

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4 Including the interactions of numeracy and the covariates did not improve the model, ΔR²(2, 143) = 2.85, p = .06, ΔR² = .03. In addition, both interactions did not attain statistical importance, |β| < .13, t < 1.34, p > .18.
differences between small numbers (i.e., 1 vs. 2 in Study 1) and may not exist for larger numbers of donation recipients (i.e., 6 vs. 60 vs. 114 in Study 3). This interpretation would be consistent with the general assumption that mental images of the victims (which are particularly important for donations of low numerate individuals; Dickert, Kleber, Peters, & Slovic, 2011) are easier to construct for small numbers (Slovic, 2007).

In contrast, more numerate individuals appear to use provided numerical information in a different manner. In Studies 2 and 3 and in line with previous findings (Peters et al., 2008), the proportion of victims helped influenced their donation decisions. Although the proportional information was not provided directly, more numerate participants appear more likely to apply numerical principles, compare presented numbers, and transform them into proportions. Even though we did not measure such mental transformations directly, the observed donation behavior is consistent with this interpretation. As shown in Study 3, these proportions impact effectiveness ratings, which in turn influence donation decisions primarily among more numerate individuals. Furthermore, our results demonstrate that a preference for higher proportional help (i.e., proportion dominance; Bartels, 2006; Fetherstonhaugh et al., 1997) may occur predominantly among more numerate individuals.

In addition, we found further evidence that more numerate individuals use number comparisons, even if this leads to suboptimal decisions. This is in line with previous results found by Peters et al. (2006, Experiment 4). In these studies, highly numerate individuals rated an objectively worse gamble with a $9-win and 5¢-loss as better than one with a $9-win and no loss; the less numerate showed no such effects, presumably because they do not rely as much on number comparisons. A criticism of this interpretation is that the effect may depend entirely on the context that is brought to mind (i.e., of “bets where you might lose” in the former and gain-only bets in the latter). A further contribution of the present paper is, therefore, that we extend Peters et al.’s number-comparison reasoning into donation behaviors where the alternative different-contexts explanation does not apply.

**Limitations, future research, and implications**

The objective of our studies was to examine the importance of numerical cues in donation decisions. Hence, we used a context-poor, limited description. By presenting such donation requests, our results extend previous research and demonstrate that less numerate individuals can be sensitive to numeric information and consider them in their donation decisions, but clear evidence for this sensitivity was found only in Study 1 for the less numerate. Presenting more detailed and competing non-numeric information might reduce the importance of numerical cues especially among the less numerate (as suggested by Dieckmann et al., 2009; see also Peters, 2012).

On the other hand, the highly numerate appear to be driven by tendencies to compare numbers and derive meaning from them (Experiment 4, Peters et al., 2006). In our studies, this comparison provides information about the proportion and effectiveness of a donation. The number-comparison focus may have led to suboptimal decisions in which the importance of single numbers (e.g., number of donation recipients) was overlooked. Future research could systematically vary the magnitude difference between and the relevance of two provided numbers and examine their effects on decisions. Although research has shown that hypothetical and real donations follow similar patterns (e.g., Kogut & Ritov, 2005b), further research should replicate our hypothetical results with real donations.

Our studies highlight that donors’ attention and use of different sources of numeric information serve as a critical factor in their willingness to help when the suffering of others is portrayed with numerical information. Specifically, our results expand previous research by showing that the effect of numeracy goes beyond number–comprehension differences to different uses of identical numerical information. We further showed that individuals lower vs. higher in numeracy follow different motivations to help others. A question that emerges from the present results is whose motivations reflect better thinking: People with lesser numeric skills seem to help more where both the help (i.e., number of recipients) and need (i.e., people at risk) are greatest. Conversely, higher numeracy is related to a more utilitarian (but perhaps morally and normatively flawed) perspective on helping such that help is provided only when it is deemed effective. From an egalitarian normative standpoint, the proportion of victims who can be saved out of the total in need should not matter (for a discussion on normative valuations of lives, see Dickert, Västfjäll, Kleber, & Slovic, 2012). One could argue that the overall number helped is what matters, but that our results point towards more numerate individuals being likely to donate.
more to help fewer people if a greater proportion is helped. More numerate individuals demonstrate awareness of the number of victims not helped (as reflected in the sensitivity for proportions). Subsequent drop-in-the-bucket thinking may deter the highly numerate from helping those who can be saved. This information-processing approach may be an inescapable aspect of their greater numeric prowess. Moreover, our finding that highly numerate individuals use particular utilitarian considerations (i.e., effectiveness) in their decisions might also be applicable in contexts other than pro-social behavior (e.g., environmental protection, consumer decisions, and economic decisions).

Even though objective numbers in a donation request are the same for all potential donors, the meaning derived from them and subsequent pro-social decisions vary according to numeracy. Media and humanitarian organizations often describe catastrophic events with large numbers of affected people to illustrate the magnitude of the problem and to increase people’s willingness to help. Although some people might use this information in the intended way, others will be demotivated to help as a large number of affected people may indicate an ineffective donation if they can only help a small proportion of them.

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