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The Relative Persuasiveness of Gain- and Loss-Framed Messages for Promoting Vaccination: A Meta-Analytic Review

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The Relative Persuasiveness of Gain- and Loss-Framed Messages for Promoting Vaccination: A Meta-Analytic Review

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Vaccination against disease is a powerful public health tool, and persuading people to be vaccinated is a correspondingly important challenge. A number of studies have compared the effectiveness of gain-framed and loss-framed appeals in this domain, often expecting gain-framed appeals to be more persuasive. A meta-analytic review ($k = 32$, $N = 11{,}814$), however, finds no significant difference in the persuasiveness of gain- and loss-framed appeals for encouraging vaccination. This conclusion is unaffected by differences in the phrasing of the outcomes invoked or by differences in the specific vaccination advocated. But the results contain a hint that parents might be more persuaded to vaccinate their children by loss-framed than by gain-framed appeals. Implications and directions for future research are discussed.

Vaccination against possible disease conditions is an important weapon in the public health arsenal. In considering how best to persuade people to undertake vaccinations, one choice faced by advocates is whether to use a "gain-framed" appeal, emphasizing the desirable consequences of vaccination, or a "loss-framed" appeal, focusing on the undesirable outcomes of failing to be vaccinated. This article provides a meta-analytic review of the accumulated research concerning the question of the relative persuasiveness of gain- and loss-framed messages for encouraging vaccination.

This question is of interest for three reasons. One is the manifest importance of vaccination. Hailed as among the greatest achievements in modern medicine, vaccines have wiped smallpox off the planet, nearly eradicated the polio virus, and substantially reduced the occurrence of infectious diseases such as measles, pertussis, and rubella. Newly developed human papillomavirus vaccines are proven effective in preventing cervical cancer, a disease that kills more than 4,000 women in the United States each year (American Cancer Society, 2009). Given the desirability of appropriate vaccination against disease, it is correspondingly important to identify effective means of influencing vaccination behavior.

Second, vaccination behavior is a theoretically significant venue for exploring gain–loss framing effects. Gain- and loss-framed appeals appear not to generally differ in persuasiveness; O'Keefe and Jensen's (2006) meta-analytic review reported that across 165 studies, there was no statistically significant difference in persuasiveness between the two appeal forms; a review focused specifically on disease prevention behaviors such as vaccination reached a similar conclusion (O'Keefe & Jensen, 2007). However, van 't Riet, Ruiter, Werrij, and de Vries (2008, 2010) have suggested that the ease of performing the advocated action may be an important moderator of gain–loss message framing effects.

Specifically, the suggestion is that when the behavior is perceived as difficult to perform, message framing variations might not differ in persuasiveness, but when the behavior is seen as easy to perform then differences (in persuasiveness) between gain- and loss-framed messages will appear. The reasoning is that if message recipients do not think themselves capable of engaging in the advocated action, then appeals about the consequences of adopting or not adopting the action have little relevance (and so are not

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differentially persuasive). The behavior's being (perceived as) easy to adopt thus is seen as a necessary condition for the appearance of gain–loss message framing effects. Vaccination is, generally speaking, a relatively simple, one-time action. Thus, even though gain- and loss-framed appeals may not generally differ in persuasiveness, the reasoning of van 't Riet et al. suggests that vaccination is just the place to expect to find any such differences.

Third, despite the accumulation of substantial research on this question, no systematic review appears to have been undertaken recently. O'Keefe and Jensen's (2007) meta-analysis identified four studies of gain–loss message framing concerning vaccination, with no significant difference in persuasiveness observed between gain- and loss-framed appeals. However, as shown later in this report, a great many studies have been conducted subsequently—there are now eight times as many studies as O'Keefe and Jensen analyzed—and hence their conclusion does not reflect the best current evidence.

POSSIBLE EFFECTS AND MODERATORS

Some theorists have expected that for disease prevention behaviors such as vaccination, gain-framed messages should be more persuasive than loss-framed messages (e.g., Salovey, Schneider, & Apanovitch, 2002). But this general hypothesis has not been borne out empirically (see the review of O'Keefe & Jensen, 2007). However, even if gain- and loss-framed appeals do not differ in persuasiveness for a given broad category of behavior, they might still differ for some specific behavior such as vaccination. And, as discussed earlier, because vaccination usually involves a one-time action, there is reason to expect that it might yield framing differences where other behaviors have not.

A great many different variables have been suggested as possible moderators of gain–loss message framing effects, including the ease of imagining disease symptoms (Bromer, 2004), the effectiveness of the recommended action (Bartels, Kelly, & Rothman, 2010), the recipient's regulatory focus or motivational orientation (Nan, in press), the valence of the language used to describe the consequences (O'Keefe & Jensen, 2006), perceived disease risk (Park, 2010), and perceived action risk (Russell, 2009). Unfortunately, many of these cannot be appropriately examined meta-analytically (e.g., individual-difference variables such as regulatory focus). Given the available data, we coded cases for three possible moderators.

One was the valence of the language used to describe the consequences of vaccination. This variable is the same as that described by O'Keefe and Jensen (2006) as the "kernel state" of the appeal—the basic outcome referred to. The contrast is between appeals mentioning desirable root states (such as "good health") and undesirable root states (such as "disease"). This moderator is of interest because of the possibility that the valence of the language used might interfere with gain–loss framing effects (as when a gain-framed appeal mentions negative states that are avoided, or a loss-framed appeal mentions positive states that are foregone).

A second was the specific vaccination advocated—human papillomavirus (HPV), hepatitis B, and so on. This moderator is of interest because of the possibility that gain–loss message framing differences might emerge for some specific vaccination behaviors but not for others. Although all vaccinations work through a similar mechanism, people's beliefs may vary from one vaccine to another concerning the nature of the vaccine, the condition the vaccine is meant to prevent, and so forth. These differences could moderate gain–loss framing effects.

A third was whether the message advocated that the message recipient be vaccinated or that the message recipient undertake to have some other person vaccinated. The latter circumstance involved messages in which parents were urged to have their children immunized. This moderator is of interest because of the possibility that people might be differentially susceptible to gain- and loss-framed appeals in one of these conditions (e.g., when their child's welfare is concerned) but not in the other.

METHOD

Identification of Relevant Investigations

Literature search. Relevant research reports were located through personal knowledge of the literature, examination of previous reviews and textbooks, and inspection of reference lists in previously-located reports. Additionally, articles were identified through computerized database searches through at least February 2011 of Business Source Complete, Communication and Mass Media Complete, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Dissertation Abstracts, EBSCO, Educational Resources Information Center (ERIC), MEDLINE, and PsycINFO, using various appropriate combinations of terms such as framing, framed, frame, appeal, message, gain, loss, positive, positively, negative, negatively, vaccine, vaccination, inoculation, and immunization.

Inclusion criteria. Studies selected had to meet three criteria. First, the study had to compare gain- and loss-framed persuasive messages. A gain-framed message emphasizes the advantages of compliance with the advocated view; a loss-framed message emphasizes the disadvantages of noncompliance. Second, the messages had to advocate vaccination (immunization). Third, appropriate quantitative data relevant to persuasive effects (e.g., attitude, intention, or behavior) had to be available; where it was not provided in the report, we made efforts to obtain information from authors. Excluded by these criteria were studies of

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other kinds of framing variations (e.g., Bigman, Cappella, & Hornik, 2010; Sperber, Brewer, & Smith, 2008) and studies for which appropriate quantitative information could not be obtained (Gainforth, 2010).

Outcome Variable and Effect Size Measure

Outcome variable. The outcome variable was persuasion, as assessed through attitude, postcommunication agreement, behavioral intention, behavior, and the like. When multiple indices of persuasion (e.g., assessments of attitude and of intention) were available, we averaged the effects to yield a single summary. Most studies reported only immediate (short-term) effects; where both immediate and delayed effect size information was available (Myers, 2009), only immediate effects were included to maximize comparability across studies.

Effect size measure. Every comparison between a gain-framed message and its loss-framed counterpart was summarized using r as the effect size measure. Differences indicating greater persuasion with gain-framed messages were given a positive sign. When correlations were averaged (e.g., across several indices of persuasive effect), we computed the average using the r-to-z-to-r transformation procedure, weighted by n.

Moderator Variables

Desirability of root states. We coded each appeal for the valence of the basic, root states mentioned in the message's description of the consequence under discussion. We coded each appeal as containing exclusively desirable root states (e.g., "long and healthy life," "peace of mind"), exclusively undesirable root states (e.g., "serious liver disease," "smallpox"), a combination of desirable and undesirable states, or as indeterminate (when insufficient detail was available about the messages).

Self vs. other vaccination. We coded each case for whether the messages advocated that the message recipient be vaccinated or advocated that the message recipient undertake to have some other person vaccinated.

Specific vaccination behavior. We coded each case for which specific vaccination was being advocated—human papillomavirus (HPV), flu (including variants such as bird flu or swine flu), hepatitis B, and so forth.

Unit of Analysis

The unit of analysis was the message pair, that is, the pair composed of a gain-framed message and its loss-framed counterpart. We recorded a measure of effect size for each distinguishable message pair found in the body of studies. Usually, a given message pair was used only in a single investigation, so only one effect size estimate was associated with the pair. But the same message pair about letrolisus (a hypothetical virus) was used by Rothman et al. (1999, experiment 1) and Sánchez (2006), so the effect sizes from these two studies were averaged and recorded as "Rothman letrolisus combined." Whenever a study included more than one message pair and reported data separately for each pair, each pair was treated as providing a separate effect size estimate (e.g., Chien, 2011).

In some cases, the same primary data served as the basis for multiple reports (e.g., both a dissertation and a subsequent publication). When a given investigation was reported in more than one outlet, it was treated as a single study and analyzed accordingly. The same research was reported (in whole or in part) in Abhyankar, O'Connor, and Lawton (2006) and Abhyankar, O'Connor, and Lawton (2008), recorded as the latter; Gerend, Shepherd, and Monday (2008) and Monday (2007), recorded as the former; Haydorov (2010) and Haydorov and Gordon (2010), recorded as the former; Lechuga, Swain, and Weinhardt (2011) and Lechuga and Weinhardt (2010), recorded as the former; Nan (2011a), Nan (2011b), Nan (in press), and Nan (2012), recorded as Nan (2012); Shen (2005) and Shen and Dillard (2007), recorded as the former; and Zimet (2008) and Zimet et al. (2008), recorded as the former.

Meta-Analytic Procedures

The individual correlations (effect sizes) were analyzed using the random-effects procedures of Borenstein and Rothstein (2005).

RESULTS

Overall Effects

Effect sizes were available for 32 cases, with a total of 11,814 participants. Details for each included case are contained in Table 1. Across all 32 cases, the random-effects weighted mean correlation was –.020. The limits of the 95% confidence interval for this mean were –.063 and .022, indicating no significant persuasive advantage for one framing form over the other ($p = .345$). This analysis, however, included one case with a very large sample size (McCaul, Johnson, & Rothman, 2002; $N = 6{,}522$); this single study contributed approximately 55% of the total N. A reanalysis excluding this case yielded a mean r of –.020 ($k = 31$), which was also not significantly different from zero ($p = .430$); the 95% confidence interval (CI) limits were –.071 and .030.

Moderating Factors

Table 2 provides a summary of the results concerning the effects of the moderating variables considered individually.

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TABLE 1
List of Cases

Study	*r*	*N*	*Codings*
Abhyankar, O'Connor, & Lawton (2008)	−.183	140	2/1/2/7
Bartels, Kelly, & Rothman (2010) E1 60%	−.210	35	2/2/1/6
Bartels, Kelly, & Rothman (2010) E1 90%	.326	35	2/2/1/6
Broemer (2004) Study 3	.196	144	1/1/1/3
Chien (2011) black-on-white	−.245	60	3/3/1/2
Chien (2011) white-on-red	.385	60	3/3/1/2
Cox, Cox, & Zimet (2006) study 2	−.056	213	2/2/1/4
Fahy & Desmond (2010)	.047	72	3/3/2/1
Ferguson & Gallagher (2007)	−.074	99	2/2/1/2
Gerend & Shepherd (2007)	−.093	121	2/2/1/1
Gerend, Shepherd, & Monday (2008) one-shot	−.343	119	2/2/1/1
Gerend, Shepherd, & Monday (2008) six-shot	.067	116	2/2/1/1
Gerend & Sias (2009) gray	.068	62	2/2/1/1
Gerend & Sias (2009) red	−.272	64	2/2/1/1
Haydorov (2010) negative attribute	.022	184	2/2/1/3
Haydorov (2010) positive attribute	.001	188	2/2/1/3
Lechuga, Swain, & Weinhardt (2011)	−.127	144	1/1/2/1
Lu (2009) exemplar	−.255	74	2/1/1/2
Lu (2009) no exemplar	.207	74	2/1/1/2
McCaul, Johnson, & Rothman (2002)	−.012	6,522	1/1/1/2
Myers (2009) episodic	−.125	237	2/2/1/5
Myers (2009) thematic	−.040	221	2/2/1/5
Nan (2012)	−.095	383	2/2/1/1
Park (2010) high-risk	−.184	54	2/2/1/1
Park (2010) low-risk	.318	54	2/2/1/1
Patel (2009)	.246	149	2/2/1/1
Rothman letrolisus combined	.037	319	2/2/1/3
Russell (2009) high-risk	.036	150	2/2/1/1
Russell (2009) low-risk	−.030	150	2/2/1/1
Shen (2005) Study 1 flu shot	.018	286	1/1/1/2
Wang & Smith (2009)	−.142	121	1/1/1/2
Zimet (2008)	.011	1,164	2/2/1/4

Note. The codings are, respectively, gain message root states (1 = only undesirable states, 2 = both desirable and undesirable states, 3 = indeterminate), loss message root states (1 = only undesirable states, 2 = both desirable and undesirable states, 3 = indeterminate), self versus other vaccination (1 = self, 2 = other), and specific vaccination behavior (1 = HPV, 2 = flu, 3 = fictitious, 4 = hepatitis B, 5 = smallpox, 6 = West Nile, 7 = MMR).

Root state valence. As indicated in Table 2, variations in how experimental messages phrased the root consequences did not materially affect the results. However, there was little variation in such phrasing. Of the 32 gain-framed appeals, 24 contained both desirable and undesirable root states, and five contained only undesirable root states; for three cases, root-state phrasing could not be determined. The mean effect for cases with both desirable and undesirable root states (mean $r = -.03$) and the mean effect for cases with only undesirable root states (mean $r = -.01$) did not differ significantly ($p = .675$).

Of the 32 loss-framed appeals, 21 contained both desirable and undesirable root states, and eight contained only undesirable root states; for three cases, root-state phrasing could not be determined. The mean effect for cases with both desirable and undesirable root states (mean $r = -.02$) and the mean effect for cases with only undesirable root states (mean $r = -.03$) did not differ significantly ($p = .848$).

Specific vaccination topic. The most common specific vaccination topic was HPV immunization (13 of the 32 cases). The mean effects in HPV studies (mean $r = -.03$) and in non-HPV studies (mean $r = -.01$) did not significantly differ ($p = .732$). As Table 2 indicates, there were generally too few studies on any one topic to permit meaningful analysis.

Vaccination for self or other. In 29 of the 32 cases, the experimental messages advocated vaccination of the message recipient; in only three cases was vaccination of some other person advocated. In neither condition was the observed mean effect statistically significant (mean *r*s of –.01 and –.11, respectively), although the effect in other-vaccination cases was nearly so ($p = .067$) despite weak statistical power (.26). The two condition means were not significantly different from each other ($p = .127$).

DISCUSSION

Overall Effects

Gain- and loss-framed appeals do not significantly differ in persuasiveness concerning vaccination. This was O'Keefe and Jensen's (2007) conclusion based on only four studies, but the 32 cases reviewed here support that same conclusion. The plain implication for message designers is that in creating messages on this subject, one need not worry about whether the appeals are gain-framed or loss-framed.

In this regard, the present research domain offers a useful example of premature generalization and application. Given the well-known hypothesis that disease prevention behaviors are more successfully encouraged by gain-framed than by loss-framed appeals (e.g., Salovey et al., 2002), one can hardly blame Webber (2003) for having recommended using gain-framed appeals to encourage medical staff to obtain flu shots: "It is more effective to say, 'The influenza vaccine will protect your income,' or 'will improve your patients' health outcomes'" whereas "A less effective message would inform the unvaccinated person that if they don't get vaccinated they will lose out on desirable things and will have to suffer undesirable things." As the present results indicate, this well-intended advice is not well founded.

Moderating Factors

Root state valence. Perhaps it is unsurprising that there was not much variation in the messages' phrasing of the root consequences. Given the nature of vaccination, it is not realistic to expect persuasive appeals to avoid mentioning the disease that is to be prevented—that is, the appeals inevitably refer to an undesirable state (a state that is avoided by compliance or that is risked by noncompliance). Naturally, then, none of the experimental messages mentioned only desirable states. Most of the messages referred to both desirable and undesirable states; a few mentioned only undesirable states. But there is no indication that it

TABLE 2
Summary of Results

	k	*N*	*Mean r*	*95% CI*	*Power*[a]	*Q(df)*
All cases	32	11,814	−.020	−.063, .022	.99	87.3(31)***
Gain message root states						
Desirable and undesirable	24	4,405	−.030	−.085, .024	.99	62.9(23)***
Undesirable only	5	7,217	−.009	−.092, .074	.99	10.4(4)*
Loss message root states						
Desirable and undesirable	21	4,117	−.023	−.078, .032	.99	51.3(20)***
Undesirable only	8	7,505	−.033	−.117, .052	.99	22.4(7)**
Self vs. other vaccination						
Self	29	11,458	−.012	−.057, .032	.99	81.1(28)***
Other	3	356	−.111	−.226, .008	.26	2.5(2)
Specific behavior						
HPV	13	1,638	−.031	−.126, .064	.81	41.6(12)***
All non-HPV	19	10,176	−.013	−.060, .034	.99	44.5(18)***
Flu	8	7,296	−.018	−.117, .082	.99	23.7(7)**
Fictional	4	835	.055	−.022, .132	.53	3.7(3)
Hepatitis B	2	1,377	.001	−.052, .054	.74	0.8(1)
Smallpox	2	458	−.084	−.175, .008	.32	0.8(1)
West Nile	2	70	.063	−.445, .539	.09	4.9(1)*
MMR	1	140	−.183	−.339,–.018	—	—

Note. Significant differences indicated by $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.
[a]These are power figures for detecting a population effect size of $r = .10$, assuming large heterogeneity, with a random-effects analysis, .05 alpha, and a two-tailed test (Hedges & Pigott, 2001).

matters much to persuasive outcomes for vaccination messages whether exclusively negative root states are mentioned as opposed to a combination of positive and negative states. This result parallels the finding of O'Keefe and Jensen's various reviews—of gain–loss message framing generally (2006), of disease prevention behaviors (2007), and of disease detection behaviors (2009).

Specific vaccination topic. There is no evidence that the persuasive effects of gain–loss message variations differ much across different specific advocated vaccinations. This conclusion must be tempered a bit because so many of the extant cases (13 of 32) concerned HPV immunization, but there was no significant difference between the mean effect in studies of HPV immunization and the mean effect in studies of other immunizations.

Vaccination for self or other. These results contain one faint hint of an intriguing potential moderator variable, namely, whether the advocated behavior was vaccination for the message recipient (mean $r = -.01$) or vaccination for someone else (mean $r = -.11$). The mean effect size for other-vaccination cases was not quite significantly different from zero ($p = .067$) or from the mean effect size for self-vaccination cases ($p = .127$)—but there were only three other-vaccination effect sizes, with correspondingly weak statistical power. The three studies in which the advocated behavior was vaccination of another person were all studies in which parents (specifically, mothers) were urged to obtain vaccinations for their children. The tantalizing possibility suggested here is that loss-framed vaccination messages might enjoy a persuasive advantage over gain-framed appeals when the message recipient is being urged to consider vaccination of some other person—as when one seeks to influence parents to have their children vaccinated.

In considering how and why such an effect might arise, one possibility is differential arousal of affective states such as guilt or regret—or, more carefully, anticipated guilt or regret. Parents quite naturally feel a special responsibility to protect their children; correspondingly, a contemplated failure to discharge such responsibilities might lead to the expectation of future regret or guilt—negative states that could be avoided by engaging in the protective action.

It seems plausible that in child vaccination messages, gain- and loss-framed appeals might differ in the ease with which they arouse (anticipated) parental emotions such as guilt or regret. Hearing "if you vaccinate your child, your child will be protected against disease" seems less likely to evoke anticipated guilt than hearing "if you don't vaccinate your child, your child won't be protected against disease." The latter appeal points specifically to a potential guilt-arousing circumstance in a way the former appeal does not.

However, all this is quite speculative. What is needed is evidence that confirms or disconfirms the hypothesis that loss-framed appeals are more persuasive than gain-framed appeals when parents are being urged to vaccinate their children (or, expressed as a more general hypothesis, when the message recipient is being urged to undertake protective action for another person for whom the recipient feels responsible). If such a difference is confirmed, then potential explanations (such as differential arousal of anticipated guilt) can be explored; hence, in gathering evidence that bears on this potential moderator, information about

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potential mediating states (e.g., anticipated guilt) might also be usefully collected.

Future Research

Given that gain- and loss-framed vaccination appeals exhibit no overall difference in persuasiveness, the question that naturally arises is whether some moderating factors might be identified, variables that influence the relative persuasiveness of gain- and loss-framed appeals on this topic. One such potential moderator, as just discussed, is whether the advocated action is vaccination of the message recipient or someone else for whom the recipient feels responsible. But researchers exploring any potential moderating factors should bear two points in mind: Replications are essential, and sample size matters. Each of these points is elaborated next.

Replications are crucial. The only convincing evidence that a given variable moderates gain–loss framing effects (whether generally or under specified conditions) consists of *replicated* moderating effects of that variable. We emphasize this point because many claims of moderator-variable effects in this domain are evidenced by a single study. For example, among the suggested possible moderators of gain–loss vaccination message framing effects are the effectiveness of the recommended action (Bartels et al., 2010), the ease of imagining disease symptoms (Broemer, 2004), the amount of effort required (Gerend et al., 2008), whether the message contains exemplars (Lu, 2009), whether the message is episodic or thematic (Myers, 2009), perceived disease risk (Park, 2010), and perceived action risk (Russell, 2009). But not one of these proposed moderators appears to have more than a single supporting study.

Without replications, however, there is not actually good evidence that any moderating effect exists. Perhaps it is too obvious to say, but: Even if a variable is observed to have significant moderating effects in one study, that provides no evidence that the effect will be obtained in other studies (with other messages, other topics, and so forth)—that is, there is no guarantee that the effect will replicate.

Color priming provides a compelling example. Gerend and Sias (2009) found that a loss-framed vaccination message enjoyed a persuasive advantage over its gain-framed counterpart when message recipients were primed with the color red (and attributed this to red's power to prime threat). But Chien (2011) obtained exactly the opposite result. When the vaccination messages were presented as black text on white background, the direction of effect favored the loss-framed appeal, but when white text appeared on red background, the direction of effect favored the gain-framed appeal. If one meta-analytically combines the results of these two studies, the mean effect size is –.090 in non-red conditions (95% CI [–.382, .218]; $N = 122$) and .063 in red conditions (95% CI [–.543, .625]; $N = 124$)—mean effects that are not significantly different.

The case of color priming offers a particularly dramatic illustration that no single study provides good evidence for moderator-variable effects. Perhaps the research community should reconsider the way in which such evidence is collected and reported. Specifically, instead of the current practice of reporting a single study (with one gain-framed message and one loss-framed message), perhaps replications ought to be included as a matter of course. Whether within a single study or across a set of simultaneously reported studies, evidence of replicated effects is crucial.

Sample size matters. The evidentiary weaknesses of unreplicated findings are amplified by the hazards of small-sample studies. In the studies reviewed here, the median N was 130.5. Designs with such sample sizes are arguably underpowered to detect effects of the magnitude to be expected. For example, with an N of 130, the power to detect a population effect size equal to a correlation of $\pm.10$ (with .05 alpha and a two-tailed test) is only .21 (Cohen, 1988).

In small-sample designs, a statistically significant result will necessarily involve a relatively large effect size. Given the bias in favor of publishing statistically significant effects, perhaps it is not surprising that in the published research literature, sample size and effect size are generally negatively correlated (Levine, Asada, & Carpenter, 2009). That relationship is also apparent in the present data. For the 16 cases with larger-than-median Ns ($N > 130.5$), the simple average of the absolute values of the effect sizes was .077. For the 16 cases with smaller-than-median Ns, the corresponding average was .202.

The implication is this: Statistically significant effects in a small-sample design may simply be outliers, results that exaggerate the true effect. As Ioannidis (2008, p. 640) put it, "When true discovery is claimed based on crossing a threshold of statistical significance and the discovery study is underpowered, the observed effects are expected to be inflated."

The remedy for these weaknesses is straightforward: more and better data, in the form of larger samples and, as discussed earlier, within-report replications. Statistically significant effects in unreplicated small-sample studies should be regarded with skepticism.

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