



Depression and suicidality as evolved credible signals of need in social conflicts

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ABSTRACT

Mental health professionals generally view major depression and suicidality as pathological responses to stress that elicit aversive responses from others. An alternative hypothesis grounded in evolutionary theory contends that depression and suicidality are honest signals of need in response to adversity that can increase support from reluctant others when there are conflicts of interest. To test this hypothesis, we examined responses to emotional signals in a preregistered experimental vignette study involving claims of substantial need in the presence of conflicts of interest and private information about the signaler's true level of need. In a sample of 1240 participants recruited from Amazon Mechanical Turk, costlier signals like depression and suicidality increased perceptions of need, reduced perceptions of manipulateness, and increased likelihood of support compared to simple verbal requests and crying without further symptoms. The effect of signaling on likelihood of support was largely mediated by the effect of signaling on participants' belief that the signaler was genuinely in need. Our results support the hypothesis that depression and suicidality, apparent human universals, are credible signals of need that elicit more support than verbal requests, sad expressions, and crying when there are conflicts of interest.

1. Introduction

In a classic study, Coyne (1976) found that depression alienates others, a result that was subsequently confirmed in numerous studies (Segrin, 2000; Segrin & Dillard, 1992). (For DSM-5 depression symptoms, see Table 1.) In interactions with spouses and others, depressed individuals express anger and aggression, make frequent demands for help, self-disclose personally relevant negative issues at inappropriate times, and view such topics as more appropriate for discussion than do the non-depressed (Segrin, 2000; Segrin & Abramson, 1994). Such self-disclosures have been shown to be a key ingredient in the rejection of depressed persons by others, and “may appropriately be understood as an attempt to elicit social support from targets” (Segrin & Abramson, 1994, p. 657). Excessive reassurance seeking – repeatedly requesting reassurance that one is lovable and worthy despite previous attempts by others to provide such reassurance – is another factor implicated in the rejection of the depressed by others (Joiner & Metalsky, 1995; Joiner, Metalsky, Katz, & Beach, 1999; Starr & Davila, 2008).

Negative social responses to depression are widely interpreted as

evidence of impaired social functioning in the depressed (Evraire & Dozois, 2011; Gadassi & Rafaeli, 2015; Gotlib & Lee, 1989; Hames, Hagan, & Joiner, 2013; Hirschfeld et al., 2000; Kupferberg, Bicks, & Hasler, 2016; Weightman, Knight, & Baune, 2019). This interpretation is reinforced by the equally widespread view that depressed individuals have impaired, negative perceptions of themselves and their environments (Beck, 1963; Joiner, 2007; Nolen-Hoeksema, 1991). Together with the costs of depression, such as profound loss of interest in virtually all activities and suicide, these facts are the basis of the mainstream claim that depression is a psychopathology.

In contrast to these views, we will argue that the depressed have suffered genuinely severe forms of adversity and are therefore genuinely in need, but often have conflicts with their social partners. In these circumstances, costly and putatively dysfunctional depressive behaviors can instead be understood as aversive but credible and adaptive signals of need that elicit more support than verbal requests, sad expressions, and crying when there are conflicts of interest. We follow Maynard Smith and Harper (2003) in defining a signal as (p. 15): “An act or structure that alters the behaviour of another organism, which evolved

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Table 1

DSM-5 criteria for a Major Depressive Episode include experiencing five or more of these symptoms, at least one of which is symptom 1 or 2. The symptoms must persist most of the day, daily, for at least 2 weeks in a row. For more details, see [American Psychiatric Association \(2013\)](#).

1. Depressed mood—indicated by subjective report or observation by others (in children and adolescents, can be irritable mood).
2. Loss of interest or pleasure in almost all activities—indicated by subjective report or observation by others.
3. Significant (more than 5% in a month) unintentional weight loss/gain or decrease/increase in appetite (in children, failure to make expected weight gains).
4. Sleep disturbance (insomnia or hypersomnia).
5. Psychomotor changes (agitation or retardation) severe enough to be observable by others.
6. Tiredness, fatigue, or low energy, or decreased efficiency with which routine tasks are completed.
7. A sense of worthlessness or excessive, inappropriate, or delusional guilt (not merely self-reproach or guilt about being sick).
8. Impaired ability to think, concentrate, or make decisions—indicated by subjective report or observation by others.
9. Recurrent thoughts of death (not just fear of dying), suicidal ideation, or suicide attempts.

because of that effect, and which is effective because the receiver's response has also evolved.”

1.1. Depression is caused by genuine adversity

All individuals suffer adversity, such as injury or loss of material or social resources, at some point in their lives, with over 70% of participants in a global survey reporting exposure to a traumatic event such as death of a loved one, being mugged, or suffering a serious injury ([Benjet et al., 2016](#)). Psychological pain, such as sadness and low mood, probably evolved to motivate victims of adversity to shift their attention to the causes of adversity so as to mitigate its negative fitness consequences and to learn to avoid future such adverse events ([Andrews & Thomson, 2010](#); [Del Giudice, 2018](#); [Nesse, 1990](#); [Thornhill & Thornhill, 1989](#)). Over human evolution, social partners could have often helped victims, and therefore signals of psychological pain, such as sad expressions and crying, probably evolved to indicate need (e.g., [Balsters, Krahmer, Swerts, & Vingerhoets, 2013](#); [Bowlby, 1980](#); [Darwin, 1872](#); [Reed & DeScioli, 2017](#)).

Contrary to the view that the depressed have a distorted perception of their environment, there is strong evidence that most cases of depression are caused by genuinely severe negative life events, such as physical assault and death of a loved one ([Devries et al., 2013, 2011](#); [Ellsberg et al., 2008](#); [Hammen, 2005](#); [Mazure, 1998](#)). Compared to non-depressed individuals, those with depression report about twice as many negative events ([Mazure, 1998](#)) and more negative events than those with schizophrenia and bipolar depression across multiple studies ([Paykel, 1994](#)). Longitudinal studies indicate that depression onsets soon after a negative event ([Han et al., 2019](#); [Kendler, Karkowski, & Prescott, 1999](#); [Lewinsohn, Hoberman, & Rosenbaum, 1988](#); [Rich, Gidycz, Warkentin, Loh, & Weiland, 2005](#); [Sen et al., 2010](#)) or coincides with periods where adversity is likely to increase prior to it (e.g., depression starting before a divorce rather than after, [Blekesaune, 2008](#); [Metsä-Simola & Martikainen, 2013](#); [Rosenström et al., 2017](#)). Although the relationship between negative events and depression is likely bidirectional (i.e., depression probably also causes adversity, [Wichers et al., 2012](#)), negative events predict depression even when considering only events outside of one's control, indicating that the connection is unlikely to be driven solely by individuals who are already depressed selecting into situations where negative events are likely to be common ([Hammen, 2005](#); [Kendler et al., 1999](#)). Furthermore, twin studies have shown that one's history of negative events remains a strong predictor of major depression when controlling for genetic similarity, and that part of the heritability of depression stems from the heritability of negative events like divorce and family conflict ([Kendler et al., 1999](#); [Kendler & Baker,](#)

2007).

For these and other reasons, we and others argue that most cases of depression are probably functional instances of psychological pain, i.e., the severe end of a spectrum of adaptive low mood, sadness, and grief, and not mental dysfunctions ([Andrews & Thomson, 2010](#); [Dowrick & Frances, 2013](#); [Frances, 2013](#); [Hagen, 1999](#); [Hagen, 2003](#); [Hagen & Syme, 2021](#); [Horwitz & Wakefield, 2007](#)). For reviews of other evolutionary theories of depression, see [Hagen \(2011\)](#) and [Durisko, Mulsant, and Andrews \(2015\)](#).

1.2. Depression, anger, and conflict

One might expect that victims of adversity who become depressed would receive positive responses from family, friends, colleagues, and perhaps even strangers. Indeed, beneficial responses to depressed individuals have also been reported, such as increased caretaking ([Hokanson, Loewenstein, Hedeon, & Howes, 1986](#)), more offers of advice and support ([Stephens, Hokanson, & Welker, 1987](#)), and reduced aggression within families ([Dadds, Sanders, Morrison, & Rebgetz, 1992](#); [Hops et al., 1987](#); [Sheeber, Hops, & Davis, 2001](#)). Why, though, would these positive responses often be accompanied by negative ones?

The missing piece of the puzzle is that depression is closely associated with anger and conflict ([Cassidello-Robbins & Barlow, 2016](#)). Of the adversity-related risk factors for depression, those that involve conflict tend to be the strongest ([Hammen, 2005](#); [Mazure, 1998](#)). Marital problems, bullying, and abusive relationships are all common risk factors for depression ([Kendler et al., 1995](#); [Kendler et al., 1999](#); [Klomek et al., 2019](#); [Klomek, Marrocco, Kleinman, Schonfeld, & Gould, 2007](#)), with sexual and non-sexual assault, in particular, greatly increasing one's risk of depression ([Kendler et al., 1995](#); [Kendler et al., 1999](#)). This holds true even in a small-scale, non-Western society: among the Tsimane, Amazonian horticulturalists, depression is also associated with conflict, especially conflict involving non-kin ([Stieglitz, Schniter, von Rueden, Kaplan, & Gurven, 2015](#)). See [Hagen and Syme \(2021\)](#) for a review of the association of depression with anger and conflict.

Other notable depression risk factors, like loss of a loved one or severe or prolonged illness, might seem less related to conflict. In these situations, however, the fitness costs that stem from reduced access to resources could be mitigated with help from social partners ([Sugiyama & Sugiyama, 2003](#)). However, social partners might not be able, or want, to provide more investment than they already are. Therefore, problems whose solutions require substantially more investment or other changes on the part of social partners will often create social conflict where none existed ([Hagen, 2003](#)). Indeed, there is evidence that loss of a loved one is often followed by increased family conflict (see [Hagen & Syme, 2021](#) for a brief review).

When need is private information and there are conflicts with social partners, “cheap” signals of need, such as sad expressions and crying, may often not be believed when providing support is costly. We argue next that in this common situation, some of the most harmful and mysterious symptoms of depression – profound loss of interest in virtually all activities, and suicidal ideation and behaviors – serve as *credible* and adaptive signals of need.

1.3. Bargaining: Credibly signaling need during conflicts

With a cooperative species like our own, ubiquitous conflicts of interests means that there will always be disagreement over the levels of investment in a cooperative endeavor and the division of the resulting benefits, even among closely related individuals. According to partner choice models, individuals who are dissatisfied with the terms of cooperation can switch partners ([Hammerstein & Noë, 2016](#)), e.g., workers unhappy with their pay can look for a better job. In many cases, however, it is difficult or impossible to switch partners. Spouses who are dissatisfied with their partner's investment in their new infant, for example, cannot easily find a different partner to invest in that infant

(Hagen, 1999). Similarly, an adolescent who is dissatisfied with her parent's investment in her cannot easily find other parents who were willing to invest more, nor could parents easily produce another adolescent. In these latter examples, and many cooperative endeavors central to human biological fitness, all parties have monopoly power over the benefits they bring to the endeavor – no one is easily replaced (Hagen, 2002, 2003). Such interdependence is increasingly recognized to be important to the evolution of cooperation in humans and other animals (Aktipis et al., 2018; Balliet, Tybur, & Van Lange, 2017; Roberts, 2005; Tomasello et al., 2012).

Hagen (2003) proposed that physical aggression and core depression symptoms like loss of interest in virtually all activities were complementary strategies to resolve conflicts in interdependent relationships. Sell, Tooby, and Cosmides (2009) found that physically formidable individuals were more prone to anger, prevailed more in conflicts of interest, and considered themselves entitled to better treatment. Physically or socially weaker individuals, though, are not without options to resolve conflicts in their favor. An individual with monopoly power over the benefits she contributes to a critical cooperative endeavor can withhold those benefits, or put them at risk, until her partners change their behaviors in ways that benefit her. As depression often involves a profound loss of interest in virtually all activities that can jeopardize one's productivity (American Psychiatric Association, 2013), it might therefore be an evolved bargaining strategy for relatively powerless individuals in the wake of adversity and social conflict (Hagen, 1999, 2002, 2003; Hagen & Syme, 2021; see also Watson & Andrews, 2002).

Bargaining models assume that delaying cooperation is costly so that there is an incentive to quickly agree on a division of benefits, especially for those who highly value the fruits of the cooperative endeavor. In a classic non-cooperative game theory model of bargaining, Rubinstein (1982) showed that two parties can come to an immediate agreement over division of benefits despite conflicts of interest if the parties' valuations of cooperation are not private information: in this case, each party knows exactly what division of benefits the other will accept, and can therefore make that offer immediately, avoiding the cost of delay.

If valuations are private information, however, costly delays might be unavoidable because each party has an incentive to deceptively request more than their actual valuation, and to reject the likely inflated requests from partners, leading to multiple rounds of bargaining. Models of bargaining with private information have a close relationship to models of credible signaling. When there are conflicts of interest, there are incentives to send deceptive signals. A *credible* signal is one that the receiver can believe despite the signaler's incentive to deceive. A willingness to delay (i.e., refuse offers) credibly reveals one's low valuation of the endeavor, and therefore genuine need – the benefit of waiting for a better offer outweighs the low cost of delay. Eagerness to reach a deal, on the other hand, credibly reveals a high valuation – the benefit of waiting for a better offer does not outweigh the higher cost of delay. Once valuations are known, the game reduces to the one analyzed by Rubinstein (1982), and the parties can reach an agreement on the division of benefits (Kennan & Wilson, 1993). Delays also typically require that additional factors come into play (Feinberg & Skrzypacz, 2005 and references therein).

Hagen (2003) proposed that whereas crying is a “cheap”, mostly short-term signal of need that might be deceptive (e.g., crocodile tears), the substantial, long-term reduction in productivity that characterizes many cases of depression corresponds to a willingness to delay, and is therefore a credible signal of low valuation and need. In terms of classic costly signaling theory, reduced productivity is relatively less costly for signalers whose efforts are currently not yielding many fitness benefits (i.e., the needy) than it would be for signalers whose efforts are yielding substantial benefits (the non-needy). Hence, the benefits of signaling outweigh the costs for needy individuals, who therefore send the signal, whereas the costs outweigh the benefits for non-needy individuals, who therefore do not send the signal.

1.4. Suicidality

Theoretical models of depression must account for suicidality. Suicidal ideation is one of nine diagnostic criteria for a major depressive episode (MDE) (American Psychiatric Association, 2013) and is associated with depression across cultures (Haroz et al., 2017); depression is a major risk factor for suicidal behavior (Hawton, Comabella, Haw, & Saunders, 2013); and suicidality is a major justification for the claim that depression is a brain dysfunction (e.g., Pies, 2014).

Anthropology, in contrast, has long viewed suicidality as largely the result of social problems. Early on, anthropologists reported on suicide attempts and deaths in the small-scale societies that serve as models for the types of societies in which humans evolved. Suicide, they found, was commonly a form of protest, revenge, and/or appeal (Firth, 1936, 1961; Malinowski, 1932; Niehaus, 2012). Some ethnographers emphasized suicide as a form of anger or social pressure (Giddens, 1964; Hezel, 1987), whereas others emphasized the powerlessness of suicide victims (Counts, 1980).

Common to almost all theoretical and empirical investigations of suicide in anthropology and other disciplines is a focus on *completed* suicides, i.e., suicide deaths. The vast majority of suicidal behavior, however, does not result in death. In young adult women in the US, for example, there are hundreds of attempts for every death (see Fig. 1). Syme, Garfield, and Hagen (2016) therefore argued that the theoretical focus should be on suicide ideation and suicide attempts.

Raymond Firth, an anthropologist who worked in the southwestern Pacific, was one of the first to view suicidality as a gamble to improve one's circumstances in the here and now. Based on observations that suicide attempts often followed loss or conflict and varied substantially in their likelihood of death, he argued that a sizable subset of the suicide attempts among the Tikopia were not meant to end in death but instead were a means to elicit aid, status, or immediate reintegration into the community following negative events (Firth, 1936, 1961).

In the bargaining framework, suicidality, and perhaps also non-suicidal self-injury (Hagen, Watson, & Hammerstein, 2008), is conceptualized as putting all future contributions to cooperative endeavors with social partners at risk with some low but non-zero probability, credibly signaling low valuation of current circumstances. On this view, most suicides deaths, especially in young, physically healthy individuals, would therefore be the inevitable consequence that some individuals lose this gamble.

As with depression, there are negative social responses to suicidal behavior. Survivors are commonly perceived as weak, selfish, mentally ill, and antisocial (Batterham, Cleave, & Christensen, 2013; Tzeng & Lipson, 2004), with stigmatization occurring both within and outside their social network (Frey, Hans, & Cerel, 2016; Scocco, Castriotta, Toffol, & Preti, 2012).

Despite this potential for stigmatization, increased social support and beneficial changes to important relationships have been reported to follow suicide attempts with some indication that these effects may hold long term (Stengel, 1956). For example, a study of 100 women who survived suicide attempts found that individuals gained identifiable benefits through the attempt in 75 cases, with 41 individuals benefiting from reconciliations with others (Lukianowicz, 1971). Unlike many Western countries, where suicide is often viewed as pathological (Hidaka, 2012), members of traditional societies often view suicide attempts as cries for help rather than mental illness (Shostak, 1981), with both victims and observers describing attempts as a way to escape unwanted marriage arrangements, persistent abuse, or social proscriptions against a romantic relationship (Gutiérrez de Pineda & Muirden, 1948; Hilger, 1957; Karsten, 1935; Tessmann, 1930; Wilson, 1960). Although findings that individuals view suicide attempts as cries for help is not necessarily evidence that they lead to beneficial responses, a study of the ethnographic record found 30 out of 84 examples of suicidal behavior resulted in positive changes for the survivor (Syme et al., 2016).

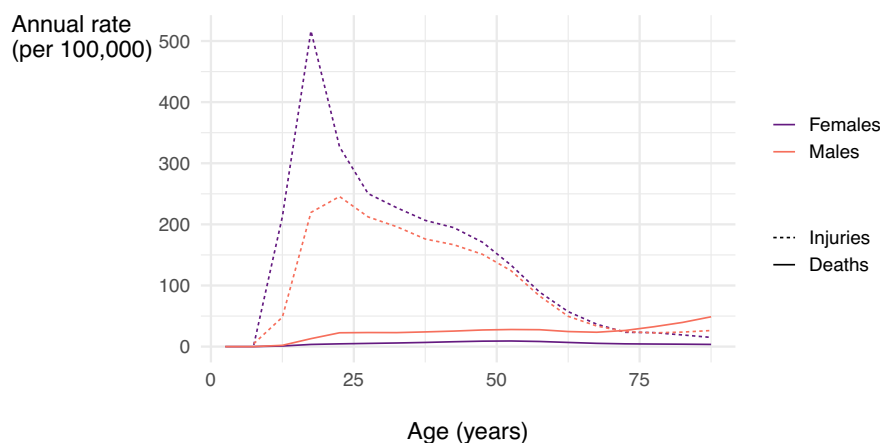


Fig. 1. US Suicidality non-fatal injury and death rates by age and sex (2001–2019). Data from CDC (2021).

1.5. Aversiveness is a feature of depression, not a bug

Under the bargaining model, aversive responses to depressive and suicidal bargaining are expected throughout the process, encouraging beneficial concessions by interdependent social partners with whom one is in conflict, who in turn signal the costliness of increasing their support (Hagen, 2003; Hagen & Syme, 2021). This predicted pattern is quite similar to anger, which is aversive to targeted social partners, yet is probably an adaptation that exploits advantages in physical or social formidability to force beneficial concessions from them (Sell et al., 2009).

We argue that among those who lack better options, aversive depression symptoms that put one's value to others at risk, such as loss of interest and suicidality, credibly signal low valuation of the current efforts of social partners and motivate them to provide more support so as to end the aversive depressive behaviors (for similar views, see Andrews, 2006; Farberow & Shneidman, 1961; Firth, 1936, 1961; Hagen et al., 2008; Nock, 2008; Rosenthal, 1993; Stengel, 1956).

1.6. Study aims and predictions

The prevailing view is that depression involves impaired social abilities that lead to rejection by social partners (Coyne, 1976; Gadassi & Rafaeli, 2015; Hames et al., 2013; Joiner et al., 1999; Segrin, 2000; Weightman et al., 2019). The aim of this study was to test an alternative hypothesis that when there are conflicts of interest, depressive and suicidal behaviors benefit victims of adversity by increasing belief that they are telling the truth and consequently increasing willingness to help them.

Most of the limited literature on social responses to depression and suicidality comprises observational studies of depressed individuals interacting with family, friends, or roommates (Dadds et al., 1992; Hops et al., 1987; Joiner & Metalsky, 1995; Sheeber et al., 2001; Starr & Davila, 2008). These have ecological validity, but cannot easily determine causal relationships. Some studies, though, have employed an experimental design in which participants were randomized into conditions in which they listened to, watched, or interacted with either a depressed or non-depressed person, where in some cases the depressed person was a non-depressed confederate enacting a depressed role (Marcus & Nardone, 1992). These designs can demonstrate causation but the transient, inconsequential relationships and laboratory settings lack ecological validity.

Experimental vignette studies, which employ a short, carefully constructed description of a person, object, or situation, aim to approach the ecological validity of observational studies by presenting participants with rich, real-world scenarios, while at the same time allowing researchers to randomize participants into conditions in which

theoretically relevant dimensions of the vignettes are systematically manipulated, thus enabling robust causal inferences (Atzmüller & Steiner, 2010). Experimental vignette studies are conducted in a broad range of disciplines, including psychology, economics, sociology, management studies, political science, and education (Aguinis & Bradley, 2014; Atzmüller & Steiner, 2010).

In the bargaining framework, one's "willingness to delay" is a credible signal of one's valuation of current cooperative arrangements, with a greater willingness to delay indicating a lower valuation. Here, we investigated responses to emotional signals that varied in the extent to which they reduced productivity or put future productivity at risk, which we refer to as costs, in an experimental vignette study in which a possible victim of adversity asks for help from the participant, but has incentives to exaggerate her need. As signal cost increased, we predicted that participants would report (1) increased belief in the signaler's claims and (2) increased likelihood of providing help, with (3) the increased likelihood of providing help mediated by the increased belief in the signaler's need.

2. Materials and methods

2.1. Design

This study utilized a between-subjects pretest-posttest design to examine how four different emotional signals (treatments) would influence (1) the degree participants believed a fictional character to be in need (*Belief*) and (2) the likelihood they would provide help (*Action*) relative to a simple *Verbal request* without additional signaling (the control condition), in four different vignettes, for a total of 20 conditions. In this design, the outcomes are measured at pre-treatment (T1). Participants are then randomized into either a control group or a treatment group, i.e., one of the emotional signals, and the outcomes are measured again (T2). Regression models (described later) are used to determine the effect of the treatment conditions on the posttest outcome variables, relative to the control condition, controlling for pretest levels of the outcome variables (we also explored within-subjects effects of the signal on outcomes at T2 compared to T1).

In principle, pretest-posttest designs, by controlling for pretest variation in the outcome, increase the precision of the estimate of the treatment effect on the outcome (Dimitrov & Rumrill Jr, 2003). In survey experiments, however, researchers often favor posttest-only designs over pretest-posttest designs. The common concern is that the pre-treatment measurement of the outcome will influence the treatment effect on the outcome (i.e., the effects of asking the same question twice) due to, e.g., demand effects, in which participants try to conform to experimenter expectations, or to consistency pressures, in which participants try to provide consistent responses regardless of treatments

(Clifford, Sheagley, & Piston, 2021). In a study with six experiments that randomly assigned respondents to alternative designs (e.g., pretest-posttest, posttest only) Clifford et al. (2021) found these concerns to be overblown. In all cases, the pretest-posttest design had substantially greater precision than the posttest-only design, with little evidence that pretest measurement altered the treatment effect.

2.2. Lessons learned from two pilot studies

The current study is a refinement of a large MTurk experimental vignette pilot study ($N = 1636$) that used a different vignette but very similar signals and outcomes (see below for more details on MTurk samples), and a much smaller pilot study posted to [reddit.com/r/SampleSize/](https://www.reddit.com/r/SampleSize/) ($N = 28$) that used draft versions of three vignettes in the current study, along with the same signals and outcomes. One major goal of the MTurk pilot study was to determine if believability and willingness to help were simply artifacts of the fictional victim’s psychiatric distress. We therefore included a “signaling” condition in which the victim exhibited schizophrenic symptoms. As predicted, believability and willingness to help in this condition were dramatically lower than in any other condition (see Fig. S1), ruling out this alternative explanation. We consequently did not include the schizophrenic condition in the current study.

A second lesson was that participants in the pilot study tended to believe the fictional victim prior to her signaling need, which made it difficult to determine if the signals increased her believability. The vignettes for this study were therefore written to undermine the victim’s credibility by making her seem manipulative at T1. See the SI for more details on the pilot studies.

2.3. Power analysis

We used the MTurk pilot data to estimate the sample sizes needed to detect an effect of the *Mild depression* signal vs. *Verbal request* control on *Belief* in the victim’s need. Power was about 80% for a sample size of about 95, and was about 90% for a sample size of about 130. See Fig. S2. Given our \$1500 USD budget, we aimed for a sample size of 120–130 for treatment plus control conditions, and 1200–1300 for all conditions in the study. For more details, see the SI.

2.4. Sampling

Participants for this study were recruited from Amazon Mechanical Turk, a crowdsourcing platform that allows for the creation of Human Intelligence Tasks (HITs) that workers can complete for pay. As Amazon provides the infrastructure, it allows for a relatively low-cost way of collecting data for academic research, with the disadvantage that the data are not representative of any real population (Thomas & Clifford, 2017). Despite this limitation, MTurk samples have a wider range of ages and incomes than most university samples, and therefore might be more informative about the general population (Dworkin, Hessel, Gliske, & Rudi, 2016; Kennedy et al., 2020; Thomas & Clifford, 2017). US MTurk samples do differ from the general US population, though, mainly in being younger, more educated, and having lower income (Boas, Christenson, & Glick, 2020; Ross, Zaldivar, Irani, & Tomlinson, 2010).

To test emotional signals in an arranged marriage vignette, we recruited an Indian MTurk sample. Indian samples are also likely to be younger, more educated, and have higher income than the general Indian population, and are more likely to come from regions with good internet access (Boas et al., 2020).

Overall, the quality of data provided by MTurk workers tends to resemble that of university sample pools (Necka, Cacioppo, Norman, & Cacioppo, 2016; Robinson, Rosenzweig, Moss, & Litman, 2019; Thomas & Clifford, 2017), with some studies reporting that MTurk samples are more attentive than samples of university students (Hauser & Schwarz,

2016). In vignette studies, MTurk data quality also compares favorably to that from much more expensive population-based samples (Weinberg, Freese, & McElhattan, 2014). For these reasons, concerns about data quality come primarily from the threat of bot use or respondents faking their location to take surveys in a language they do not understand well, with there being little evidence of the former (Kennedy et al., 2020) and the risk of the latter able to be minimized through well designed attention checks, timed responses, and good study design (Aguinis, Villamor, & Ramani, 2020; Huang, Bowling, Liu, & Li, 2015; Kennedy et al., 2020; Thomas & Clifford, 2017).

2.5. Participants

All participants were over 18, located in the United States or India, and had high quality MTurk metrics (completed at least 100 HITs with a HIT approval rate of over 98%, Kennedy et al., 2020). Participants were excluded from the study if (1) they read the vignette too quickly (one-third of the time it took MG to read it), and (2) they failed clearly labeled attention checks. The first attention check was shown immediately after the consent form and provided participants with a random word and asked them to enter the vowels in the order in which they are found in the word. The second attention check followed the vignette and involved asking three questions about the story that were easy to answer for anyone paying attention.

2.6. Ethics

All participants provided informed consent, and the consent form warned that some content might involve sexual assault. We estimated the study would take 4–8 min to complete for participants who did not take breaks (MTurkers commonly multitask, or leave the survey page and return later, Necka et al., 2016). All participants who passed the attention checks were paid \$1 for their time, for an estimated rate of \$7.50/h to \$15/h (75% of US participants completed in 8.4 min; 75% of Indian participants completed in 25 min). This study was certified exempt by the Washington State University Human Research Protection Program.

2.7. Survey

Four vignettes were used in this study that involved (1) a female’s claim of severe adversity that was private information, (2) conflicts of interest between the victim and the participant that would undermine the believability of her claims and make her seem manipulative, and (3) her emotional signals. The vignette scenarios involved potentially severe types of adversity, such as sexual and non-sexual assault and thwarted marriage, that often precede cases of depression and suicidality in the ethnographic and clinical record (Brown, 1986; Kendler et al., 1999, 1995; Syme et al., 2016). See Table 2.

Table 2
The cooperative endeavor, conflict of interest, and private information in each vignette.

Vignette	Cooperative Endeavor	Conflict of interest	Private information
Thwarted marriage	Inclusive fitness (parent-offspring)	Parental investment in sibling	Value of arranged marriage with second man
Basketball coach	Winning the championship	Coach’s investment in other players; keeping the coach	Did sexual assault happen?
Romantic partner	Inclusive fitness (parent-offspring)	Investment in offspring vs. romantic partner	Did physical assault happen?
Brother-in-law	Inclusive fitness (parent-offspring)	Investment in child vs. investment in adult sibling and niece	Did sexual assault happen?

2.7.1. Time 1: Claim of need in a conflictual relationship

At Time 1 (T1) participants in the US sample were randomly assigned to either the “basketball coach,” “romantic partner,” or “brother-in-law” vignettes, and the Indian sample was assigned to the “thwarted marriage” vignette.

2.7.1.1. Basketball coach vignette. Participants were asked to imagine that they are a university athletic director. The star player on the women’s basketball team comes to the participant and claims she was sexually assaulted by her head coach, a physically powerful man. However, there is a history of conflict between the star player and the coach over playing time, and police are unable to find evidence to corroborate her claims.

2.7.1.2. Brother-in-law vignette. Participants were asked to imagine that they let their sister, brother-in-law, and niece move in with them after their sister’s family lost their house in a fire. During this time, the participant’s 15-year-old daughter becomes jealous of the niece, who appears to be a social competitor. A few weeks after claiming the niece was trying to steal her boyfriend, the participant’s daughter accuses the brother-in-law of sexually assaulting her.

2.7.1.3. Romantic partner vignette. Participants were asked to imagine that they found a highly desirable romantic partner after years of being single. However, the participant’s 13-year-old daughter, who has a history of interfering with the participant’s past relationships, is clearly unhappy with the new partner. After a period of sustained conflict with both the participant and the romantic partner, the daughter accuses the romantic partner of physically assaulting her, but cannot produce any evidence.

2.7.1.4. Thwarted marriage vignette. Indian sample only. Participants were asked to imagine that their family was trying to arrange a dowry for their older daughter (the signaler in this vignette) so she can marry a man she already loves, while still saving enough money for their younger daughter’s dowry. After the man’s family demands more money, the participant’s family tries to find a second man, who the older daughter claims to find unattractive. Any increase in the dowry will come at the younger daughter’s expense. The participant therefore proceeds to arrange a marriage to the second man as the first man’s family makes arrangements with a different woman.

The full vignettes are available in the SI.

2.7.2. Baseline measures (T1)

After reading the vignettes, participants rated their belief that the signaler was telling the truth (*T1 Belief*: 0–100) and the likelihood of them helping the signaler as requested (*T1 Action*: 0–100). With the thwarted marriage vignette we also asked how they would split the money they had saved for the dowry between their daughters (*T1 Divide*: 0–100; 50 is equal split). In every instance, the order of the questions was randomized to avoid order effects (Krosnick & Alwin, 1987).

Responses were recorded with sliders due to the fact they allow for finer grained changes than categorical scales (Klimek et al., 2017). Based on findings that a slider’s starting position may bias results (Liu & Conrad, 2019), we had concerns that participants would be less likely to move away from intermediate starting values than they would be in reality. For this reason, we set each T1 slider to start fully to the left (0). For the exact wording of the question and the labels on the sliders, see Table S1.

We also asked which emotions participants felt the signaler was experiencing using a multiple-choice question in which they could select as many options as they would like. This included emotions directly

related to the signals (e.g., sad, depressed, and suicidal), states which suggest genuine need (traumatized and violated), states which suggest deception (e.g., deviousness or jealousy), and if the victim was mentally ill. The complete list can be found in the SI. To further explore the effect of signaling on participants’ inferences of the signaler’s emotional state, we created two new variables: *Low mood* was the sum of the binary variables *Depressed*, *Distressed* and *Sad*; and *Manipulative* was the sum of the binary variables *Devious* and *Jealous*.

2.7.3. Time 2: Signals

After rating their beliefs and actions, and which emotions they thought the potential victim was experiencing, participants were randomized into either the control condition or one of four emotional signals by the victim (in order of increasing signal cost): (1) control condition: a verbal request without additional signaling; (2) crying; (3) mild-depression; (4) depression; and (5) a suicide attempt. The signals involved the participant encountering the victim some time after the adverse event and observing, e.g., crying; sad expressions; reduced effort, fatigue, and poor personal hygiene; and suicidal self-injury. These descriptions did not use the terms depression, depressed, suicidal, or mental health.

The signals were cumulative: crying can be an important feature of depression (for discussion on the relationship between crying and depression see Bylsma, Gračanin, & Vingerhoets, 2021), and depression is a major risk factor for suicide (Bostwick & Pankratz, 2000; Kessler, 2012). Accordingly, components of less-costly signals were included in more-costly signals. Although we use the term ‘signals’ throughout the paper for brevity, we expect that the hypothesized signals of need, like many signals, would also provide information to others in the form of cues (for discussion on the evolution of signals from cues see: Biernaskie, Perry, & Grafen, 2018; Steinkopf, 2015; Tiokhin, 2016). The complete texts of the signals are available in the SI.

2.7.4. Post-treatment measures (T2-T3)

After reading the signaling text, participants answered questions identical to those asked at T1 as the main post-treatment variables of interest (T2). For the *Belief*, *Action*, and *Divide* variables, the position of the slider starting where participants placed it at T1. T2 emotion multiple-choice questions were identical to those used in T1, as were the composite variables *Low mood* and *Manipulative*.

As both a validity check and a way to understand the degree participants would be willing to help if they believed the participant completely, at T3 we presented participants with strong evidence that the claims were true. In the US sample, this involved telling participants there was video evidence of the event in question occurring or a similar event after the fact. With the thwarted marriage vignette, this involved the participant seeing the man their daughter wants to marry trash-talk their daughter and their family. Participants were then asked to rate their likelihood of acting (*T3 Action*).

2.7.5. Demographic questions

The final part of the survey was a brief demographic questionnaire which asked for the (1) age, (2) sex, (3) number of siblings, (4) number of sons, (5) number of daughters, (6) current relationship status, (7) highest level of education, and (8) the annual household income of each participant.

2.8. Statistical analyses: Preregistered and modified

Our intervention was *signal*, an ordinal variable with the following preregistered rank order: verbal request (control), crying, mild depression, depression, suicide attempt. We coded this 5-level ordinal factor

variable using default 4th-order orthogonal polynomial contrasts. We preregistered a test of our hypothesis that used ordinary least squares (OLS) regression models with the following form:

$$\text{BeliefT2} = \beta_0 + \beta_1(\text{BeliefT1}) + \beta_2(\text{signal.L}) + \beta_3(\text{signal.Q}) + \beta_4(\text{signal.C}) + \beta_5(\text{signal}^4)$$

$$\text{ActionT2} = \beta_0 + \beta_1(\text{ActionT1}) + \beta_2(\text{signal.L}) + \beta_3(\text{signal.Q}) + \beta_4(\text{signal.C}) + \beta_5(\text{signal}^4)$$

We predicted that there would be a statistically significant monotonically increasing effect of the signal on *Belief* and *Action*.

We decided to fit generalized linear regression models instead of OLS, however, for the following reasons. Our pre-test and post-test measures, *T1* & *T2 Belief* and *T1* & *T2 Action*, were all measured on a 0–100 point scale. A substantial number of participants rated their beliefs and actions as exactly 0 or exactly 100 at either *T1* or *T2*. OLS linear regression models are not suitable for a closed and bounded distribution with so many values on the boundary because the residuals would not be normally distributed or have constant variance. For further discussion, see the SI, where we also report the preregistered OLS models.

To test our preregistered hypothesis that the likelihood of acting to help the victim would be largely mediated by a signal’s positive impact on the participant’s belief in the victim’s need, we used the mediation package (Tingley, Yamamoto, Hirose, Keele, & Imai, 2014) to fit a mediation model for *Depression* treatment vs. *Verbal request* control. We did the same for *Suicide attempt*. See Fig. 2.

For specifications of all regression models, see the SI. Our preregistration is here: <https://osf.io/g3s6n>

2.9. Data availability

The data are available at <https://doi.org/10.5281/zenodo.4637904>. Study code is available at <https://github.com/michaelrgaffney/signaling2020mturk> (note that the data contains participants who did not finish the survey or who did not pass quality checks – the code removes them).

3. Results

The study was started by $N = 1950$ participants who clicked the link to Qualtrics (1213 US and 737 India). After removing participants who did not finish the survey, failed attention checks, or moved through the study at an unrealistic pace ($N = 710$, 36%), our final sample was $N = 1240$ (937 US and 303 India), with 759 males and 479 females, 609 of whom were married or in a long-term relationship, 205 who were divorced, 414 who were single, and 11 who were widowed. The median number of participants per condition was 61 (min = 58, max = 67). For the number of participants in each condition, see Table S2. For summary statistics, see Table 3. For the distributions of participants by age, income, and nationality, see Fig. S3.

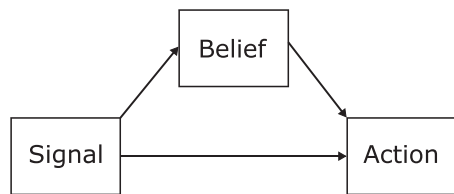


Fig. 2. Possible causal effects of the signal on helping behavior. A credible signal of need increases belief that the victim is telling the truth and needs help, which increase the likelihood of helping. The direct path from the signal to action represents other causal effects of the signal on observers, such as perceptions of the victim’s emotional state (and other factors not measured in this study) that might alter observer behavior.

Table 3

Summary statistics for study variables. Values that were on a 0–100 scale were rescaled to 0–1. Indian participants reported income in rupees, which we converted to USD at the current exchange rate (1 rupee = 0.014 USD).

Variable	N	Range	Mean (SD)
Age (years)	1240	18–81	37 (12)
Income (USD)	1235	0–840,000	53,000 (60000)
Education (years)	1238	11–24	16 (2.1)
Number of children	1236	0–11	1 (1.3)
Time to complete (minutes)	1240	1.6–1700	13 (50)
T1 Belief	1240	0–1	0.38 (0.3)
T1 Action	1240	0–1	0.37 (0.32)
T1 Division	303	0.14–1	0.58 (0.15)
T1 Low mood	1240	0–3	1.3 (1.1)
T1 Manipulative	1240	0–2	1 (0.74)
T2 Belief	1240	0–1	0.48 (0.33)
T2 Action	1240	0–1	0.49 (0.35)
T2 Division	303	0.14–1	0.62 (0.16)
T2 Low mood	1240	0–3	1.7 (1.1)
T2 Manipulative	1240	0–2	0.53 (0.7)
T3 Action	1240	0–1	0.88 (0.22)

3.1. Distributions of beliefs and actions at Time 1

Across the four vignettes, mean belief of the victim (after rescaling original 0–100 values to 0–1) was relatively low at baseline (*T1*), Mean = 0.38, albeit with wide variation, SD = 0.3; 118 participants (9.5%) rated their belief = 0, and 38 participants (3.1%) rated it as = 1. The distribution of likelihood of helping the victim (action) was similar, Mean = 0.37, SD = 0.32, with 168 participants (14%) rating their action = 0, and 57 participants (4.6%) rated action as = 1. Although not a pre-registered prediction, *T1 Belief* and *T1 Action* were highly correlated across the four vignettes, consistent with help being worth providing if the signaler’s claims were true (see Fig. 3).

3.2. Confirmatory: Signals increase beliefs and actions in the predicted rank order

As predicted, there was a strong statistically significant positive causal effect of the ordinal signal on *T2 Belief* (LR $\chi^2(4) = 221, p = 1.3 \times 10^{-46}$) and *T2 Action* (LR $\chi^2(4) = 259, p = 7.3 \times 10^{-55}$), controlling for *T1 Belief* and *T1 Action*, respectively, with the effect of each signal increasing in the predicted rank order (verbal request, crying, mild depression, depression, suicide attempt). See Fig. 4 and models m1 and m3 in Tables S4 and S5. Results for the preregistered OLS models were very similar; see Figs. S21 and S22, and Tables S6 and S7. The within-subject effects of each signal are depicted in Fig. S7.

The estimated marginal mean between-subjects effect of the high cost *Suicide attempt* vs. the *Verbal request* control on *T2 Belief* (averaging over all four vignettes and all values of *T1 Belief*) was an increase of 21 (95% CI: 18–25) points on the original 0–100 point scale. The equivalent increase for *T2 Action* was 27 (95% CI: 23–30) points. Given that the standard deviations of *T2 Belief* and *Action* are 33 and 35, respectively, these represent increases of 0.65 and 0.81 standard deviations, respectively.

3.3. Confirmatory: The effect of signals on action is largely mediated by belief

According to our theoretical model, emotional signals that put cooperative benefits at risk increase observers’ belief that the victim is genuinely in need. Increased belief then increases the likelihood of helping the victim (action). See Fig. 2.

We fit the mediation and outcome models using GLM’s with the binomial family as the mediation package does not support the quasibinomial family. The total effect of the *Suicide attempt* signal (treatment) vs. *Verbal request* (control) on the likelihood of *Action* was to increase it

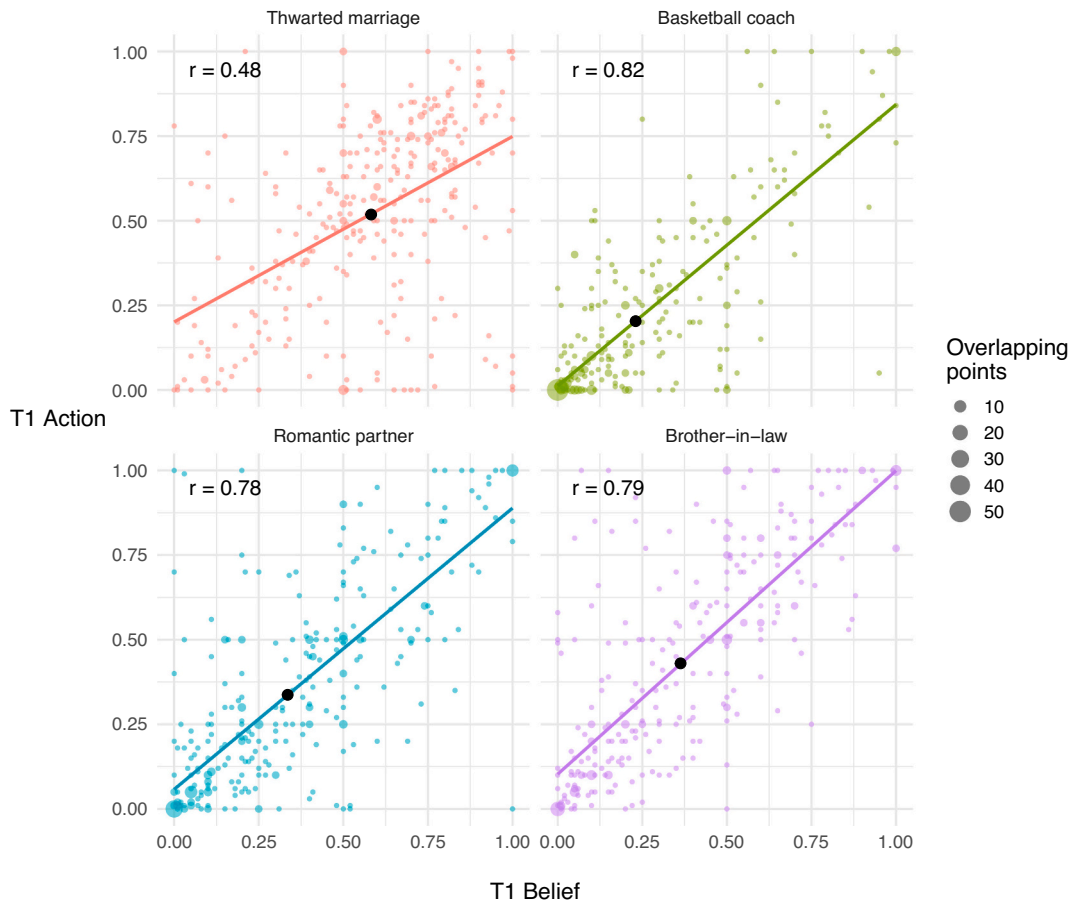


Fig. 3. The distributions of *T1 Belief* vs. *T1 Action*, by vignette. Each dot is one participant. Original 0–100 values rescaled to 0–1. Lines fit by linear regression. Dot size indicates the number of overlapping points. Black dot is the mean of each variable.

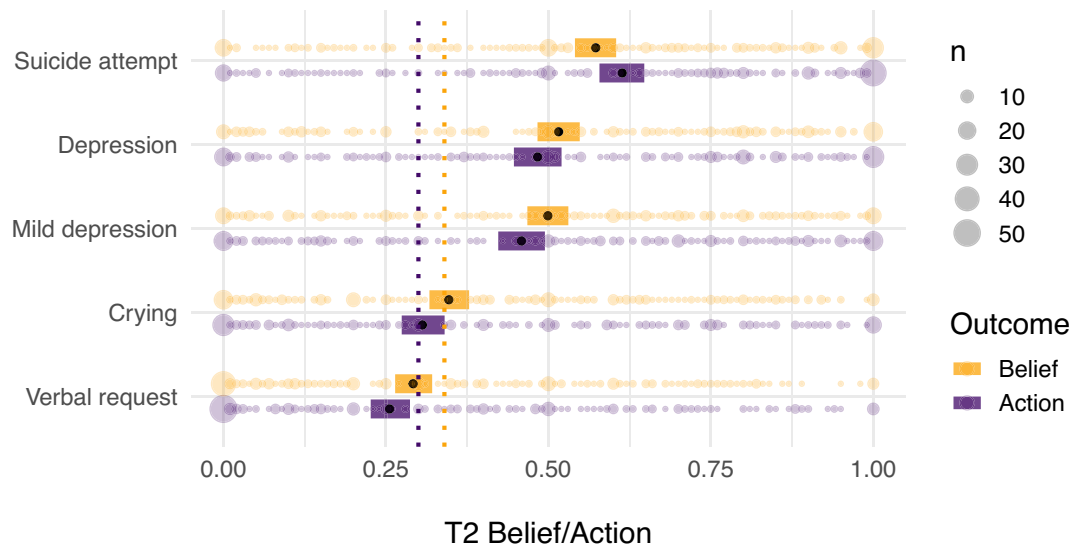


Fig. 4. The mean effects of the signals on *T2 Belief* and *T2 Action*, controlling for *T1 Belief* and *T1 Action*, respectively (original 0–100 scale rescaled to 0–1). Effects plotted for *T1* values set to their median values (*T1 Belief* = 0.34, *T1 Action* = 0.3), indicated by the dotted vertical lines. Fit using generalized linear regression models with the quasibinomial family. Bars are 95% CIs. Dots are *T2 Belief* and *T2 Action* values; dot size = number of overlapping data points. For coefficients, *p*-values, and other statistics, see models m1 and m3 in Tables S4 and S5.

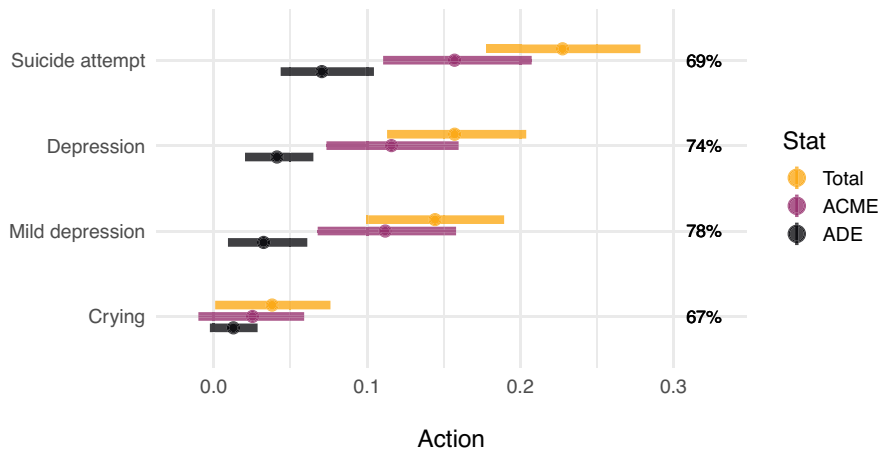


Fig. 5. The mediated effects of each signal (treatment) vs. *Verbal request* (control) on *Action*. The x-axis is the change in *Action* on the [0, 1] scale. The effects of the signals on *Action* are largely mediated by *Belief* (percent mediated on the right). The mediation model controlled for *T1 Belief*, and the outcome model controlled for *T1 Belief* and *T1 Action*. Both models were GLMs with the binomial family (the mediation package does not support the quasibinomial family). ACME: Average causal mediation effect. ADE: Average direct effect. Total: Total effect (ADE + ACME). Bars are 95% CIs.

by 23 points from T1 to T2 (on the original 100-point scale). Of this increase, 69% was mediated by the increased *Belief* that the victim was telling the truth. The total effect of the *Depression* signal (treatment) vs. *Verbal request* (control) on the likelihood of *Action* was to increase it by 16 points from T1 to T2. Of this increase, 74% was mediated by the increased *Belief* that the victim was telling the truth. See Fig. 5.

3.4. Exploratory: Costlier signals decrease perceived manipulation and increase perceived low mood

T1 to T2 for each signal in each vignette reveals a large decrease in inferred *Manipulation* for costly signals, and a large increase in inferred *Low mood* (with the exception of the thwarted marriage vignette, in which changes are small). See Fig. 6.

The proportion of participants inferring each emotion in each vignette at T1 and after each signal at T2 is depicted in Fig. S8, and the change in proportions from T1 to T2 in Fig. S9. The increase in inferred depression in the *Depression* and *Suicide attempt* conditions, but not the *Verbal request* and *Crying* conditions, helps validate these signals, as does the increase in inferred suicidality in the *Suicide attempt* condition.

At baseline (T1), 16% of participants thought the victim was

The mean change in the *Low mood* and *Manipulative* variables from



Fig. 6. The within-subjects effect of the signals on participants' inferred *Manipulative* and *LowMood* emotional states of the victim, from T1 (arrow base) to T2 (arrow head), for each signal in each of the four vignettes. *Low mood*: higher values indicate lower perceived mood. *Manipulative*: higher values indicate higher perceived manipulateness. Thick arrows: mean change. Thin arrows: means of 500 bootstrap resamples.

mentally ill, which decreased slightly at T2 in the *Verbal request* and *Crying* conditions (13%), and then increased with signal cost to 20% in *Mild depression*, 31% in *Depression*, and 47% in *Suicide attempt*, with some variation by vignette. See Figs. S10 and S11. Perceived mental illness at T2 was associated with lower T2 Belief and Action in the US sample, but this effect was mainly evident in the *Verbal request* and *Crying* conditions. See Figs. S12 and S13.

3.5. Exploratory: Signal effects differ by vignette

The effects of the signals on rated beliefs and actions differed substantially by vignette, which we display in three ways for each signal in each vignette: estimated cumulative distribution function plots, which show the entire distributions of rated beliefs and actions, including which conditions have high fractions of 0's and 1's (Fig. 7); regression estimates of the mean effects of the signals on beliefs and actions by vignette (Fig. 8); and between- and within-subjects signal effect sizes (Cohen's d) by vignette (Figs. S4 and S5).

We note the following patterns in Fig. 7, which we will return to in the Discussion section. First, as we intended, the distributions of *Belief* and *Action* in the *Verbal request* control condition were very similar to their distributions at T1 baseline across vignettes. In the “basketball coach” and “brother-in-law” vignettes, though, their distributions in the *Verbal request* condition were shifted to somewhat lower values relative to baseline (i.e., the verbal request slightly *reduced* belief and action in those vignettes). Second, in the “romantic partner” and “brother-in-law” vignettes, the effect of *Crying* differed little from *Verbal request*, but in the “basketball coach” vignette, it differed little from the *Depression* and *Suicide attempt* signals. Third, the effect of the *Suicide attempt* signal on *Belief* was similar to that of *Depression* across all vignettes, but had a noticeably greater effect on *Action* in the “romantic partner” and “brother-in-law” vignettes. Fourth, there was little difference between the effect of the *Mild depression* vs. *Depression* signals.

The largest between-subjects effect was *Suicide attempt* vs. *Verbal*

request control on *Belief* in the “brother-in-law” vignette, Cohen's d = 1.7, and the smallest was the effect of *Crying* on *Belief* in the “romantic partner” vignette, Cohen's d = 0.085. The largest within-subjects effect was *Suicide attempt* on *Action* at T2 vs. T1 in the “brother-in-law” vignette, Cohen's d = 1.5, and the smallest was the *negative* effect of *Verbal request* on *Action* at T2 vs. T1 in the “brother-in-law” vignette, Cohen's d = 0.25.

3.6. Exploratory: Sociodemographic associations

The sociodemographic variables were strongly confounded with nationality (Indian participants were younger, lower income, with more years of education than US participants; see Fig. S3), which, in turn, were confounded with vignette (responses in the Indian thwarted marriage vignette differed substantially from those in the US vignettes). We therefore conducted our exploration of the sociodemographic variables separately by nationality.

In the US sample, female participants were more likely to believe and help the victim than male participants, and younger participants were more likely to believe and help the victim than older participants. We found no significant effects of *Income*, *Education*, relationship status (e.g., married, single), or number of sons or daughters on *Belief* or *Action*. See Fig. S16.

In the Indian sample and vignette, in contrast, males were more likely to help the victim than females, those with more years of education were less likely to believe the victim, and there was a marked increase in likelihood of helping among older individuals in the suicide signal condition. We found no significant associations with age or income. See Fig. S17.

3.7. Validity check: large T3 increase in Action with proof that victim was telling the truth

As a partial check on the validity of our methods and results, at T3 we

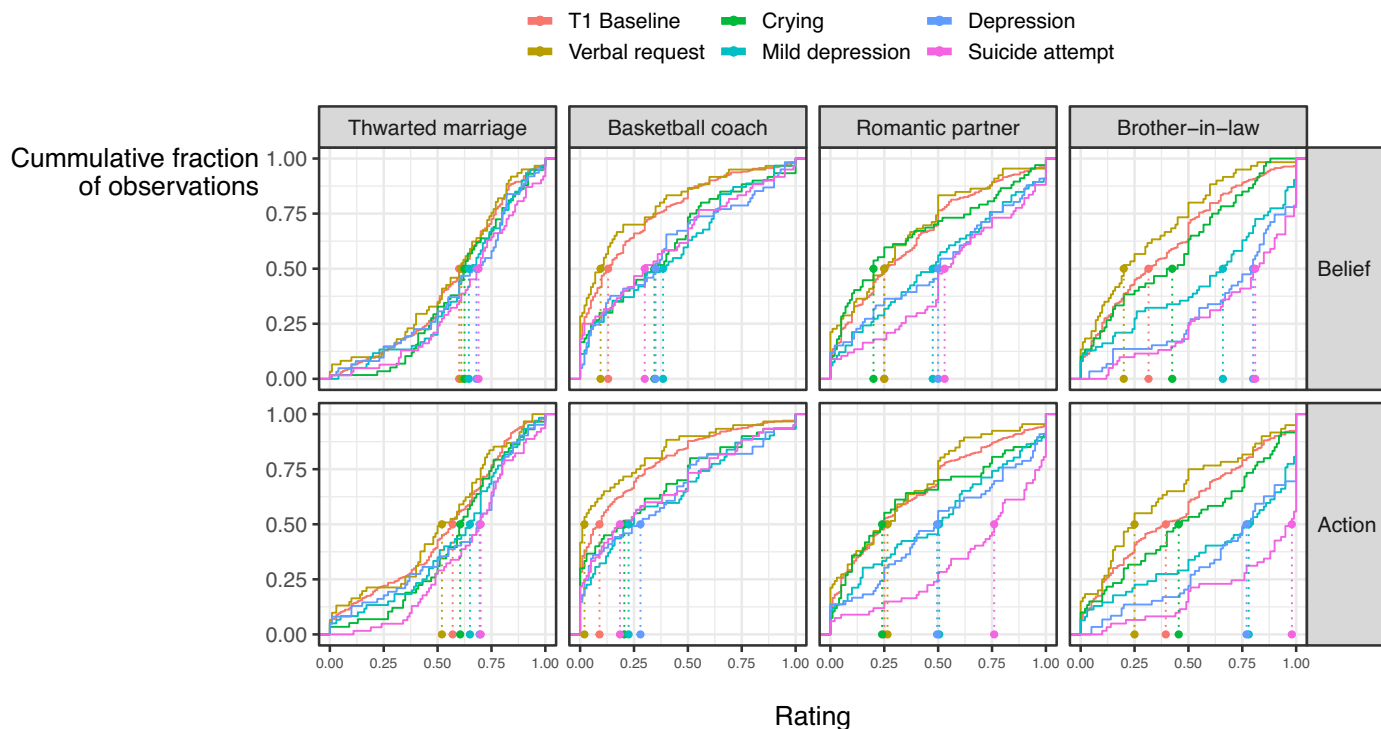


Fig. 7. Empirical cumulative distribution functions for Time 2 *Belief* (top) and *Action* (bottom) compared to their Time 1 baseline values (red), by signal and vignette. Y-values indicate the fraction of all ratings equal to or less than a given x-value. Ratings rescaled to [0, 1]. Dots indicate median values of *Belief* and *Action*, by signal and vignette. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

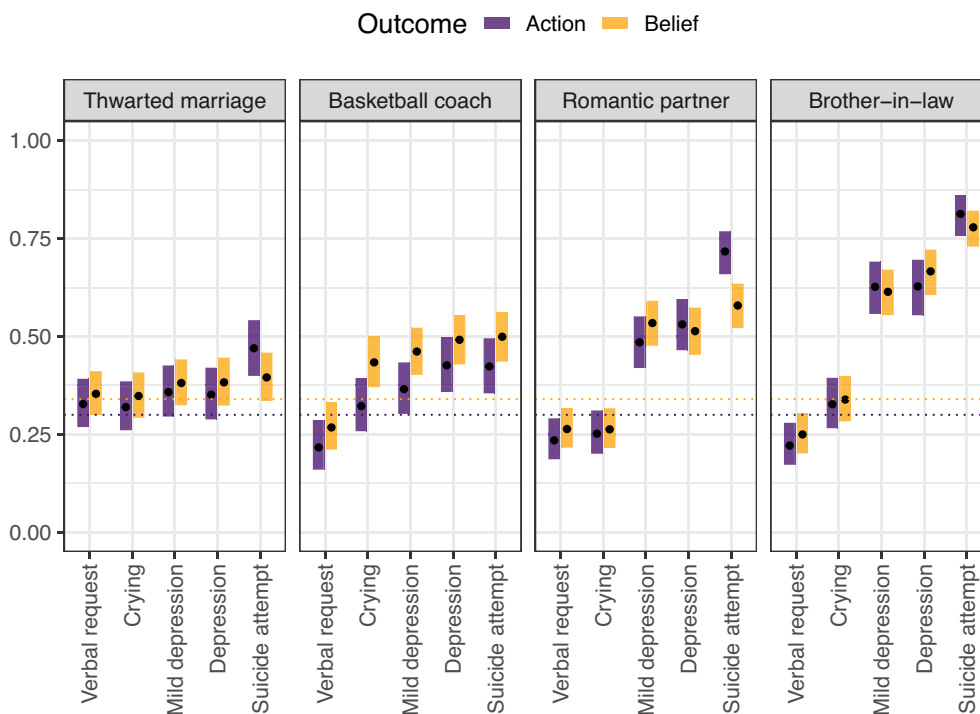


Fig. 8. The effect of the signals on $T2$ Belief and $T2$ Action in each vignette, controlling for $T1$ values of Belief and Action, respectively. Ratings rescaled to [0, 1]. Effects plotted for $T1$ values set to their median values ($T1$ Belief = 0.34, $T1$ Action = 0.3), indicated by the dotted horizontal lines. Fit using generalized linear regression models with the quasibinomial family. Bars are 95% CIs. For coefficients, p -values, and other statistics, see models m2 and m4 in Tables S4 and S5.

presented participants with strong evidence that the victim was telling the truth, and asked them to again rate their likelihood of acting to help the victim ($T3$ Action). Compared to the mean $T2$ Action ($M = 0.49$), mean $T3$ Action increased substantially, Mean diff. = 0.389, $t(1239) = 35.2$, $p < 2.2 \times 10^{-16}$. Across the US vignettes, likelihood of acting at $T3$ increased to near-ceiling ($M = 0.96$), regardless of participants' $T2$ Action values, indicating that propensity to act was indeed contingent on believing the victim. In the Indian thwarted marriage vignette, however, there was little change in $T3$ Action compared to $T2$ Action (Fig. S18), perhaps because Indian participants' beliefs and actions were relatively insensitive to the signals to begin with (Figs. 7 and 8).

4. Discussion

As predicted, in vignettes involving conflicts of interest and private information about the need for help, costly signals of need increased participants' belief in the victim's claims and their likelihood of helping her, with the increase in belief and the likelihood of helping increasing monotonically with signal cost. As predicted, the increase in likelihood of helping was largely mediated by the increase in belief in the victim's claims. In an exploratory analysis, costlier signals also decreased perceptions that the victim was manipulative. These results provide evidence that, contrary to the influential "interpersonal" view that depressive behaviors are socially dysfunctional (reviewed in Hames et al., 2013), they in fact outperform verbal requests, sad expressions, and crying in providing benefits to victims when there are conflicts of interest.

Signal effects were largest in the "brother-in-law" and "romantic partner" vignettes, both of which involved claims of assault against participants' imagined daughters, and smaller in the "basketball coach" and the "thwarted marriage" vignettes. The smaller effect in the "basketball coach" vignette might have been because in the role of athletic director, participants did not value their relationship with the star player as much as we anticipated (e.g., due to lack of relatedness), or how participants weighted the costs of suspending the coach vs.

punishing a potentially innocent person (for discussion of suicidal signaling to kin vs. nonkin, see Syme & Hagen, 2018). The US vignettes also had different degrees of evidence against the victim beyond just denial by the accused, ranging from strong evidence in the basketball coach vignette (a negative police report) to moderate evidence in the romantic partner vignette (no physical injuries) to weak evidence in the brother-in-law vignette (nothing beyond denial by the brother-in-law), raising the possibility that credible signals are more effective when negative evidence is lacking (Dylan Tweed, personal communication).

The small signal effect in the "thwarted marriage" vignette, which involved the Indian sample, could indicate that our results do not generalize across cultures, undermining our adaptationist hypothesis. It could also reflect our poor understanding of contemporary Indian culture regarding dowry (the effect was larger in older participants). Baseline belief in the older daughter, and likelihood of helping her, was relatively high at baseline (58%) compared to victims in the other vignettes. Private information and conflict therefore probably played a smaller role and thus costly signals were less necessary. We observed a similar pattern in our pilot study, in which baseline belief in the victim's need was high, and costly signals had smaller effects than they did in the current study. Additionally, supporting the older daughter came at the cost of one's younger daughter, which may also help explain the relatively small signal effects. A final consideration is that data from the Indian sample appeared to be of lower quality, limiting our confidence in any of these interpretations (see the Limitations section for more information).

In the "brother-in-law" and "romantic partner" scenarios, Crying had little effect on the magnitude of pro-victim responses relative to Verbal request, suggesting it was not costly enough to serve as a reliable signal in times of substantial conflicts of interests. In contrast, both Depression conditions increased support, albeit to similar degrees. One potential reason for the similar effects of the Depression conditions is the increase in costs from Mild depression to Depression was small (e.g., grades dropping from As to Bs in Mild depression vs. Cs in Depression). Such small changes may be less impactful in vignettes than in real-life, where the

effects of signaling may increase in severity as they persist over time.

The effect of *Suicide attempt* on *T2 Belief* was similar to the *Depression* conditions across vignettes, but it resulted in greater *T2 Action*. One interpretation is that although some participants did not believe the victim's story, her signal nevertheless convinced them that she needed help. For example, maybe the brother-in-law did not assault her, but the presence of his family in her home was causing genuine distress. Support for this interpretation comes from our mediation analyses, which showed that the likelihood of help was largely, but not entirely, mediated by signal's effect on belief in need.

There were minor associations of age and sex with *T2 Belief* and *T2 Action* in the US participants, with both being higher among females and younger individuals. The US vignettes all involved assaults against young women, which might have been more salient to female and younger participants. In the Indian sample, *T2 Belief* and *T2 Action* were somewhat lower among those with more education and among females, respectively. Costlier signals, suicidality in particular, had a larger effect among older individuals, perhaps because older individuals were more likely to have children of marriageable age, like the victim in the vignette.

Contrary to our adaptationist hypothesis, and supporting the mainstream view that depression is a psychopathology, participants' perceptions that the victim was mentally ill increased with signal cost. However, there have been extensive media campaigns to convince the public that depression is a mental illness with the laudable goal of reducing stigma (Corrigan, 2012; Rüscher, Angermeyer, & Corrigan, 2005). Even so, in the *Depression* conditions across vignettes, no more than 25% of participants thought the victim was mentally ill, and in the *Suicide attempt* condition the proportion of participants perceiving mental illness exceeded 50% only in the basketball coach vignette. Although perceived mental illness was associated with somewhat lower *T2 Belief* and *T2 Action*, this effect was mainly evident in the *Verbal request* and *Crying* conditions.

Finally, after the T3 evidence that the victim was telling the truth, likelihood of helping by the US participants increased to near ceiling, an effect that helped validate our vignettes. Among Indian participants, in contrast, participants only slightly increased their likelihood of helping from their T2 level. One interpretation of the latter is that Indian participants tended to believe the older daughter anyway, so their decision to help was not changed by additional information.

4.1. Limitations

This study has less ecological validity than real-world observations of depressed individuals interacting with their social partners, which might have biased results in a pro-signaler direction if the lack of real costs of helping made support feel less costly or if there was a social desirability bias toward helping (Grimm, 2010). It may have also biased participants against helping if they could not fully imagine the characters in the story as kin or interdependent partners, and the survey's short duration may have weakened the strength of the costlier signals as bargaining tools.

Our design did not include vignettes with male signalers. For this reason, we have no data on the possibility of sex differences in the effectiveness of the signaling strategies examined. Although not predicted theoretically, such differences are possible if the costs of signaling vary between the sexes due to differential access to alternative bargaining strategies (Hagen & Rosenström, 2016) or if one sex tends to suffer greater negative reputational effects when displaying the emotions and behaviors in the vignettes. It is also possible the costliness of the situations presented in the vignettes differ by sex. This study therefore most clearly demonstrated the effectiveness of costly signals of need by females, leaving open the question of the effectiveness of costly signals of need by males.

Compared to the US sample, far more Indian participants failed our attention checks, which is consistent with botting, unfamiliarity with English, or low-effort responses (Kennedy et al., 2020). If this high

failure rate indicates lower-quality responses among those who passed the attention checks, the weak signal effect in the thwarted marriage vignette may simply be due to greater noise rather than differences in the scenario or the effectiveness of the signals compared to those in the US. Another concern relevant to all vignettes is that our decision to anchor the T1 sliders at 0 may have resulted in participants being more likely to report extreme values.

Finally, we adopted game theory models of bargaining with incomplete information as our theoretical framework, but there are many other models of credible signaling (e.g., Számádó, 2011), including for need (Számádó, Czégel, & Zachar, 2019) and suicidality (Rosenthal, 1993). If depression and suicidality involve signaling, they might be better explained by a different model.

5. Conclusion

Depression is costly and sometimes leads to death by suicide. Our results indicate that these costs, which mainstream theories take as evidence of brain dysfunction, instead function to help victims of adversity elicit support when their true level of need is private information and they have conflicts with social partners. Our findings align with real-world evidence that depression and suicide simultaneously elicit positive and negative responses from social partners (for review, see Hagen & Syme, 2021). In particular, sexual assault, which appeared in two of our four vignettes, is the biggest risk factor for a suicide attempt (Dworkin, Menon, Bystryński, & Allen, 2017; Husky, Guignard, Beck, & Michel, 2013). Our results strongly suggest that a major reason for this pattern is that the victim's social partners are skeptical that she is telling the truth. If the bargaining model is correct, depression and suicidality are aversive but adaptive responses to adversity and conflict (Hagen, 2003; Syme & Hagen, 2020).

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.evolhumbehav.2022.02.004>.

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