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Lying Aversion and the Size of the Lie[†]

By Uri Gneezy, Agne Kajackaite, and Joel Sobel*

This paper studies lying. An agent randomly picks a number from a known distribution. She can then report any number and receive a monetary payoff based only on her report. The paper presents a model of lying costs that generates hypotheses regarding behavior. In an experiment, we find that the highest fraction of lies is from reporting the maximal outcome, but some participants do not make the maximal lie. More participants lie partially when the experimenter cannot observe their outcomes than when the experimenter can verify the observed outcome. Partial lying increases when the prior probability of the highest outcome decreases. (*JEL* C91, D12, D90, Z13)

Situations frequently arise in which people can lie about their private information. Although lying is common, compelling real-world and laboratory evidence shows that people sometimes avoid telling lies that would increase their material payoffs.[1]

Some honest behavior is an optimizing response to material incentives; people are honest because dishonesty might lead to punishment. Businesses may avoid making false claims because if caught they would face substantial penalties. Individuals in long-term relationships may resist opportunities to make short-term gains through lying in order to maintain profitable relationships. In these cases, honesty may be an optimal response for an agent who trades off the short-term benefits of lying with the long-term consequences. These situations are common and important, but standard models suffice to describe them. Laboratory evidence suggests that in addition to these instrumental motivations, honesty has intrinsic value. This paper pursues

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[1] Examples of experimental evidence include: Abeler, Becker, and Falk (2014); Abeler, Nosenzo, and Raymond (forthcoming); Cohn, Fehr, and Maréchal (2014); Dreber and Johannesson (2008); Erat and Gneezy (2012); Evans et al. (2001); Fischbacher and Föllmi-Heusi (2013); Gneezy (2005); Lundquist et al. (2009); Hannan, Rankin, and Towry (2006); López-Pérez and Spiegelman (2013); Mazar, Amir, and Ariely (2008); Sutter (2009); and Shalvi et al. (2011).

the idea that there are intrinsic costs associated with lying and provides theory and evidence about the form of these costs.

Lies come in different sizes. Some lies are more plausible than others. Some lies influence monetary payoffs more than others. The literature contains informal discussions of lying costs that identify different ways to measure the size of lies and its interaction with lying costs. For example, Mazar, Amir, and Ariely (2008) and Fischbacher and Föllmi-Heusi (2013) suggest that the marginal cost of a lie is increasing in the magnitude of a lie, leading to the prediction that individuals might lie a little bit, but not take full advantage of strategic opportunities. Our paper introduces intrinsic costs of lying and systematically connects these costs to the size of the lie. It derives equilibrium behavior and generates testable predictions.

We argue that the intrinsic cost of lying depends on the size of the lie and identify three different ways to measure this size: the payoff dimension (monetary gains of lying), the outcome dimension (the distance between what the agent observes and what she says), and the likelihood dimension (the ex ante probability that the agent's report is true). The following example illustrates the three dimensions of lying costs. Suppose a participant rolls an n-sided die and receives a positive payoff if she reports a five (and zero otherwise). One could vary the payoff dimension of lying costs by varying the payoff associated with reporting five. A dishonest report of five is a bigger lie in the payoff dimension if the reward for reporting five is bigger. To identify the outcome dimension of lying, one could ask how the frequency of reports of five varies with what the subject observes. If lying costs are associated with the outcome dimension, then one might conjecture that the closer their observation is to five, the more subjects lie; for example, they would be more likely to report five if they observed four than if they observed two.[2] Finally, to illustrate the likelihood dimension of lying costs, imagine changing the probability of rolling a five. The larger is n, the larger the lie on the likelihood dimension is to report five. That is, bigger lies are statements that are less likely to be true ex ante.

In Section I, we introduce a basic model that generates predictions regarding how varying the size of the lie on each of these three dimensions affects behavior. We assume that utility is the sum of three terms: the first is the monetary payoff, the second depends directly on the true state and the report (and indirectly on the monetary payoffs associated with these reports), and the third term depends on the probability that an observer believes the report is honest. The second term captures the outcome and payoff dimensions, whereas the third term captures the likelihood dimension.

Without the likelihood dimension, the theoretical model is a straightforward decision problem. Adding the likelihood dimension complicates the analysis because it adds a strategic aspect.[3] To incorporate the likelihood dimension, we follow Akerlof

[2] The experiment by Lundquist et al. (2009) is a good way to understand the outcome dimension. Their participants play a deception game (Gneezy 2005) in which first the Sender takes a test and then sends a message regarding the results of the test to the receiver. The Sender receives a fixed positive payoff if the receiver believes that she passed a certain threshold in her test. Because only two payoffs are possible (zero if not passing, and a fixed payment if passing), the size of the lie on the payoff dimension is constant. However, the size of the lie can be based on how close the sender's performance was to the actual threshold, which is how Lundquist et al. (2009, p. 82) define the size of the lie: "We test whether the aversion to lying depends on the size of the lie (i.e., that the aversion to lying is stronger the further you deviate from the truth)…"

[3] Four recent papers, Abeler, Nosenzo, and Raymond (forthcoming); Dufwenberg and Dufwenberg (2017); Garbarino, Slonim, and Villeval (2016); and Khalmetski and Sliwka (2016), introduce models that capture the likelihood dimension. We discuss these models after we present our formal results in Section II.

and Kranton (2000); Bénabou and Tirole (2011); Tajfel (1978, 2010); Tajfel and Turner (1979); and Turner and Onorato (1999), who argue that agents place an intrinsic value on "social identity." These theories posit that the way others—even strangers—perceive an individual determines that individual's social identity. Social identity concerns may influence an agent's behavior even if she does not anticipate further interactions. In that sense, social identity is fundamentally different from traditional discussions of reputation. At the same time, these theories permit identities to be based on an internal notion of what is appropriate behavior. We assume that agents wish to be perceived as being honest and therefore gain utility from appearing honest. This utility could be instrumental (if people who are perceived to be honest get treated better). We focus, however, on the interpretation that being viewed as honest is an intrinsically valued part of an agent's social identity. This intrinsic preference provides a motivation for an agent to sacrifice monetary payoffs in order to appear honest.

In Section II, we present the theoretical results of the model. The model makes a unique prediction. The equilibrium involves a cutoff value—if the agent draws an outcome above the cutoff, she never lies. If she draws an outcome below the cutoff, she may lie and, if she lies, she makes a claim above the cutoff. Furthermore, we find that higher claims are perceived to be less likely to be honest. Therefore, agents tell partial lies in equilibrium if social identity concerns are large enough. However, in equilibrium, dishonest claims of the maximal value arise with positive probability. Our most novel findings are qualitative results that capture the intuition that reducing the ex ante probability of the maximal outcome increases the frequency of partial lies. We interpret this finding as evidence that the likelihood dimension is an important part of the cost of lying. In Section III, we summarize the theoretical findings in order to motivate the hypotheses that we test experimentally.

In Section IV, we describe the experiment, which is based on the design of Fischbacher and Föllmi-Heusi (2013). Our experiments manipulate three characteristics of the game. First, we compare a game in which the experimenter may observe the subjects' outcomes to one in which the experimenter cannot observe the outcome, even ex post. Second, we vary the way in which the outcomes are labeled. Finally, we vary the prior distribution of outcomes to understand how the likelihood of outcomes affects behavior through social identity concerns.

Section V describes the experimental results. We find that people lie and a large fraction of those who lie report the maximum lie. In addition, people report more partial lies when no one observes their outcomes than when outcomes can be observed by the experimenter ex post. This finding is consistent with social identity concerns, because every lie leads to the worst possible social identity in the observed game, whereas the social identity is typically decreasing in the size of the lie in the game in which outcomes cannot be observed.[4] Another prediction that is consistent with the existence of social identity concerns is that participants tell more partial lies when the ex ante probability of the highest state decreases. Finally, with respect to the

[4] Stated differently, in the observed game, social identity is binary: partial lies and maximal lies lead to the same social identity. In the non-observed game, the social identity associated with telling the maximal lie is strictly less than that of a partial lie.

outcome dimension, we show that the fraction of dishonest reports does not depend on how outcomes are labeled, but the labels influence the frequency of partial lies.

I. Model

An agent's type consists of a pair (i,t), where $i = 1,\ldots,N$, $t \in [0,T]$, N is a positive integer, and $T > 0$. The value i represents the agent's observation, which can be thought of as the outcome of a roll of a die; the value t is the fixed cost of lying. The quantities i and t are independently distributed; $p_i > 0$ is the probability that the agent receives i; $F(\cdot)$ is the cumulative distribution function of t. The agent makes a claim, k, which is also assumed to be a number between 1 and N. We call an agent honest if she reports i when her type is of the form (i,t); she is dishonest (and her report is a lie) otherwise.[5] The agent receives a monetary reward of v_j if she reports j; if $i < j$, then $v_i < v_j$.

Denote the probability that an agent reports j given (i,t) by $s(j\,|\,i,t)$.[6] That is, an agent's strategy s maps type (i,t) into a probability distribution over reports.

We assume that an agent's preferences depend on three elements: the monetary payoff, costs associated with the relationship between her value i and her report j, and the extent to which her behavior influences her social identity. We assume that the utility function takes the form

$$v_j - C(i,j,t) + \beta\gamma_{ij}(s) \tag{1}$$

for $\beta > 0$, but we limit the analysis to a special case of this functional form by imposing restrictions on the second and third terms.

First, we assume

$$C(i,j,t) = \begin{cases} 0 & \text{if } i = j \\ t + c(i,j) & \text{if } i \neq j \end{cases}.$$

The function $C(\cdot)$ represents the direct cost of lying. We measure the social identity cost with the third term. We assume that the agent values honest behavior or being perceived as behaving honestly. The perception can be part of the agent's self image or it could be part of how the agent is viewed by others (social identity). The function $\gamma_{ij}(\cdot)$ captures this element of preferences. We specialize the expression in (1) by assuming γ_{ij} takes the form

$$\gamma_{ij}(s) = \lambda(I_{ij} - 1) + (1-\lambda)\,\rho_j(s), \tag{2}$$

where

$$I_{ij} = \begin{cases} 1 & \text{if } i = j \\ 0 & \text{if } i \neq j \end{cases},$$

[5] In this model, the agent's claim is about her observation. Lying about intentions is not possible in our framework. The question of whether the lying-cost structure is the same when lying about intentions is possible is left for future research.

[6] $s(j\,|\,i,t) \geq 0$ and $\sum_{j=1}^{N} s(j\,|\,i,t) = 1$ for all i and t.

$\lambda \in [0,1]$, and $\rho_j(s)$ is the probability that a report of j is interpreted as being honest. Note that $\rho_j(s)$ depends on the strategy profile s and is computed using Bayes' Rule. Therefore, $\rho_j(s)$ can be written

$$\rho_j(s) = \frac{h_j(s)}{h_j(s) + r_j(s)}, \tag{3}$$

where

$$h_j(s) = \int_0^T s(j \mid j,t)\, dF(t)\, p_j \tag{4}$$

is the probability that j is reported honestly and

$$r_j(s) = \sum_{i=1,\, i\neq j}^{N} \int_0^T s(j \mid i,t)\, dF(t)\, p_i \tag{5}$$

is the probability that j is reported dishonestly. It must be that $r_j(s) \geq 0$ for all j. If $h_j(s) + r_j(s) = 0$, then $\rho_j(s)$ is not defined. This possibility does not arise because our assumptions on the distribution of lying costs will guarantee $h_j(s) > 0$.

The definition of $\gamma_{ij}(\cdot)$ in (2) spans two situations. When $\lambda = 1$, the social identity term depends only on whether $i = j$. This specification is relevant when the agent's value i is publicly observed and no uncertainty exists regarding whether a report is dishonest, so it models the "observed game" experiments we conduct. When $\lambda = 0$, the social identity term depends only on the inferences an observer can make knowing the reported value j and the strategy s, without knowing the observation i. This specification applies to the "non-observed game" experiments, provided the agent's social identity depends only on how others perceive her behavior. When $\lambda \in (0,1)$, our specification includes both a self-assessment of social identity and the perception of others. Because we view both self-assessment and perception as potentially relevant, these cases are the focus of our analysis. An agent with correct beliefs about whether she is observed and whose social identity depends only on how others perceive her sets $\lambda = 0$ in the non-observed game and $\lambda = 1$ in the observed game. Even if the agent cares only about how others view her behavior, values of λ strictly between zero and one may be appropriate in the non-observed game. For example, the agent may have incorrect beliefs about the beliefs of others (and, in particular, may believe that the observer knows what she knows).

Given our specifications of $C(\cdot)$ and $\gamma_{ij}(\cdot)$, we can rewrite the utility of a type (i,t) agent who reports j as

$$U(i,j,t;s) = \begin{cases} v_j + \beta(1-\lambda)\,\rho_j(s) & \text{if } i = j \\ v_j - c(i,j) - t - \beta\lambda + \beta(1-\lambda)\,\rho_j(s) & \text{if } i \neq j \end{cases}. \tag{6}$$

We also maintain additional assumptions on the cost function $c(\cdot)$ throughout our analysis. We assume that $c(\cdot)$ is nonnegative, $c(i,i) = 0$, weakly increasing in $|i-j|$, and $c(i,j) + c(j,k) \geq c(i,k)$. We also assume that $c(N-1,N) < v_N - v_{N-1}$. These conditions include as a special case a model in which there is a categorical cost of lying ($C(i,j) = 0$ if $i = j$ and otherwise the lying cost is positive and

independent of i and j). We use condition $c(N-1,N) < v_N - v_{N-1}$ to avoid the uninteresting case in which the cost of lying is so great that no one wishes to make the highest report dishonestly.

With these assumptions, we can normalize the lying costs and define α as $\beta(1-\lambda)$. These considerations lead to the functional form for preferences that we use for the analysis:

$$U(i,j,t;s) = \begin{cases} v_j + \alpha\,\rho_j(s) & \text{if } i = j \\ v_j - c(i,j) - t + \alpha\,\rho_j(s) & \text{if } i \neq j \end{cases}. \tag{7}$$

(The "t" specification in (7) replaces $t + \beta\lambda$ in (6); this is the normalization of fixed costs of lying.)

Finally, we assume that the distribution over types $F(\cdot)$ is continuous, has support $[0,T]$, $F(0) = 0$, and that $T > v_i - v_{i-1}$ for all $i = 1,\ldots,N$.[7] Combined, these conditions guarantee that almost all agents find lying costly and that some agents find lying so costly that they will never lie. In particular, they guarantee the denominator in the expression for $\rho_j(\cdot)$, (3), is always positive.

Some properties depend on whether the parameter α in (7) is zero or strictly positive. The case $\alpha = 0$ corresponds to when the observer knows the agent's true value. Increases in α correspond to the agent placing increasing weight on appearing honest to individuals who do not observe the agent's true value.

Representation (7) is special. It leaves out factors that may be important.[8] Distributional concerns may play a role, but no other active agents are in our experiments. Our specification assumes that the subject does not care about the experimenter's monetary payoff. The social identity term is a reduced form that captures some concerns the subject has about how she is perceived. Additive separability, homogeneous preferences over monetary payments, and risk neutrality may be important restrictions.[9] The assumption that $c(i,j) + c(j,k) \geq c(i,k)$ simplifies our analysis because it guarantees that if anyone dishonestly reports k, then no one who observes k will be dishonest.[10] Assuming t enters the cost function separably means, conditional on wanting to lie, the preferences of type (i,t) do not depend on t. The notation suppresses the possible dependence of costs on the monetary payoffs (v_j); we imagine that if v_j changes, the cost of claiming j dishonestly would change. The cost function $c(i,j)$ is defined for $i > j$, but we will show that in equilibrium no agent will report less than what she observes. We chose this specification because it is tractable—in particular, it permits us to show (in Lemma 1) that ρ_i is uniquely determined in equilibrium when $\alpha > 0$—and rich enough to provide testable hypotheses.

[7] Our results do not require that 0 is in the support of $F(\cdot)$, but it simplifies the exposition to be able to guarantee that a type $(N-1,t)$ agent will lie if t is sufficiently small. This property holds for t near zero if $c(N-1,N) < v_N - v_{N-1}$. If $[\underline{t},T]$ is the support of $F(\cdot)$ for $\underline{t} > 0$, then we can assume instead that $c(N-1,N) + \underline{t} < v_N - v_{N-1}$. We do make use of the property that $F(0) = 0$, which guarantees that $t > 0$ with probability one.

[8] For example, Charness and Dufwenberg (2006) study how promises and the desire to keep promises influence honest behavior. Erat and Gneezy (2012) study the decision to behave honestly when distributional concerns are present. Kajackaite (2016) shows that the intrinsic cost of lying about ability is higher than the cost of lying about luck. Marcin (2016) argues that agents may report honestly to signal ability.

[9] One can view v_k as measured in utils, so risk neutrality is not restrictive given separability and homogeneity.

[10] We find that our data are consistent with the prediction that if anyone dishonestly reports k, then no one who observes k will be dishonest.

We analyze an equilibrium in this setting, which consists of strategies $s(k \mid i,t)$ such that:

(i) $s(k \mid i,t) \geq 0$ for all k,i,t and $\sum_{j=1}^{N} s(j \mid i,t) = 1$ for all i and t,

(ii) $s(k \mid i,t) > 0$ only if k maximizes (7) (with respect to j),

(iii) $\rho_j(s)$ is computed using (4) and (5).

There exists t^* large enough such that all types of the form (i,t) with $t > t^*$ would prefer to report i instead of $j \neq i$ independent of ρ. We assume that $t^* < T$, which guarantees that the set of t such that $s(i \mid i,t) > 0$ has positive probability for all i. Consequently, the denominator in (3) is strictly positive.

The existence of an equilibrium in which each type (i,t) plays a pure strategy follows from standard arguments (Schmeidler 1973).[11]

The game we study posits that there exists a single agent who makes an observation and decides what to report by maximizing utility with respect to beliefs. It is formally equivalent to view the game as one in which different agents make observations. This point of view is consistent with our experimental design, but it is arguably less plausible to assume that ρ_j is independent of (i,t) when (i,t) represents the type of a single subject rather than the characteristics of a member of a large population. At the same time, we have no evidence or theoretical reason to think the beliefs of different individuals should be systematically different. For this reason, we maintain the (equilibrium) assumption that the interpretation of reports does not vary with (i,t) and view our model as an useful representation of the experimental game.

The definition of equilibrium requires that beliefs are statistically correct (property (c)). This assumption is less important for our conclusions. We have pointed out that the subject can have incorrect beliefs about the probability that she is observed (formally, she can have incorrect beliefs about λ).

II. Analysis

This section describes properties of equilibria. The first main property is that the social identities generated in equilibrium must be unique. We also show how equilibrium behavior depends on the prior distribution.

We denote strategies by s (or s', s''), the associated social identities by ρ_k (or ρ_k', ρ_k''), and the utility without lying costs of a report by W_k (or W_k', W_k'') so that $W_k = v_k + \alpha \rho_k$. The first result identifies a structural property of equilibrium strategies.

PROPOSITION 1: *If there exists $t' > 0$ such that $s(k \mid j,t') > 0$ for $k \neq j$, then for all $i \neq j$ and $t > 0$, $s(j \mid i,t) = 0$.*

[11] Schmeidler's theorem guarantees the existence of a pure-strategy equilibrium in a game in which a continuum of players exists and each player has a finite action set. The result applies to our game by treating each type as a player.

In words, Proposition 1 states that if some agent finds lying valuable when the true state is j, then no agent will dishonestly report j.

PROOF:

If $s(k|j,t') > 0$, then

$$W_k - C(j,k,t') \geq W_j. \tag{8}$$

To prove the proposition, it suffices to show that for all t,

$$W_k - C(i,k,t) > W_j - C(i,j,t). \tag{9}$$

By inequality (8), $W_k - W_j \geq C(j,k,t')$. However,

$$C(j,k,t') > c(j,k) \geq c(i,k) - c(i,j) = C(i,k,t) - C(i,j,t), \tag{10}$$

where the strict inequality follows from the definition of $C(\cdot)$ when $t' > 0$ and the equation follows (for all t) by the definition of $C(\cdot)$. The weak inequality holds because $c(i,j) + c(j,k) \geq c(i,k)$. Inequality (9) follows immediately from inequalities (8) and (10). ∎

Proposition 1 implies no observed outcome j exists with the property that some type (j,t') would lie while another would dishonestly report j. To get an intuition for the result, consider the leading case where $k > j > i$. The maintained assumption that $c(i,j) + c(j,k) \geq c(i,k)$ implies that once someone has made the decision to lie, the marginal cost of increasing the size of a lie (in outcome space) is non-increasing. Hence if after observing j a subject is willing to pay the fixed cost (to report k instead of j), no subject who observes $i < j$ would prefer making a dishonest report less than k to reporting k.

Proposition 1 has two consequences. The first consequence (Corollary 1) is that if there exists a type (j,t) that lies, then someone who does not know the observed value views j as an honest report. The first consequence follows because the proposition states that if there exists a type (j,t) who lies, then no one dishonestly claims j. Hence, any report of j must be honest. The second consequence is that no one ever makes a claim that is less than the truth. The second consequence (Proposition 2) follows because if $j > i$, then $v_j > v_i$. If type j reports i, then $\rho_j = 1$. So $W_j > W_i$ and type (j,t) would be better off reporting honestly than reporting i.

COROLLARY 1: *If* $s(k|k,t) < 1$ *for some* $t > 0$, *then* $\rho_k = 1$.

PROOF:

Proposition 1 implies that if $s(k|k,t) < 1$, then the probability that another type reports k, r_k, is equal to zero. The result follows from the definition of ρ_k (given in equation (3)) and $h_k \neq 0$. ∎

PROPOSITION 2: *If* $i < j$, *then* $s(i|j,t) = 0$ *for all* $t > 0$.

PROOF:

If $s(i|j,t) > 0$ for $j \neq i$, then $W_j \leq W_i - C(j,i,t)$ and, by Corollary 1, $\rho_j = 1$. It follows that $v_i > v_j$, and therefore $i > j$. ∎

The model provides a unique equilibrium prediction in the sense that all equilibria give rise to the same set of values for ρ_k. The next result implies that the set of claims that are made dishonestly does not depend on the equilibrium selected.

LEMMA 1: *Suppose* $\alpha > 0$. *If* s' *and* s'' *are two equilibria, then* $\rho'_k = \rho''_k$ *for all* k.

The lemma requires that social identity matters ($\alpha > 0$). If $\alpha = 0$, then $\rho_1, \ldots, \rho_N$ do not influence preferences, so uniqueness of these values is not important. Equilibrium utilities are unique for all α.[12]

An intuition for the result follows. Suppose two equilibria exist that give rise to different ρ. Suppose that moving from the first equilibrium to the second, the social identity for reporting k goes down by the most over all possible reports. Thus, reporting k dishonestly in the second equilibrium is less attractive. However, if the probability of dishonest reports of k in the second equilibrium is lower, then the value associated with reports of k must be higher in the second equilibrium. (This observation requires that the number of honest reports of k does not go down, which follows from Proposition 1.) Consequently, all ρ_k must be higher in the second equilibrium. One can use the same argument to show that all ρ_k are higher in the first equilibrium. Therefore, the proposition must hold.

PROOF:

Let M be the set of minimizers of $\rho'_j - \rho''_j$. If

$$W'_k - C(i,k,t) \geq W'_j - C(i,j,t),$$

then $W''_k - C(i,k,t) + \alpha((\rho''_j - \rho'_j) - (\rho''_k - \rho'_k)) \geq W''_j - C(i,j,t)$. Hence, if $k \in M$, then $W''_k - C(i,k,t) \geq W''_j - C(i,j,t)$ with strict inequality unless $j \in M$. It follows that if $s'(k|i,t) > 0$ for $i \neq k$, $k \in M$, then $s''(j|i,t) = 0$ for all $j \notin M, j \neq i$. We claim that

$$\sum_{k \in M} r'_k \leq \sum_{k \in M} r''_k. \tag{11}$$

To establish (11) suppose that $s'(k|i,t) > 0$ for $i,k \in M$, $i \neq k$. Observe that i can also be a best response for type (i,t') for at most one value of t'. Hence the probability that type i makes an honest report to the set M under $s''(\cdot)$ while being

[12] Even when $\alpha = 0$ the ρ_j are uniquely determined in equilibrium for "most" parameter values. Formally, treat the parameter values, $c(i,j)$, $i < j$, $i = 1, \ldots, N-1$, $j = 2, \ldots, N$, and v_i, $i = 1, \ldots, N$ as elements of $\mathbb{R}^{N(N-1)/2}$. A type (i,t) agent either tells the truth or selects the report $j \neq i$ that maximizes $v_j - c(i,j)$. There exist distinct i,j,k such that $v_j - c(i,j) = v_k - c(i,k)$ for a subset of parameter values that is closed and has Lebesgue measure zero. Consequently, equilibrium behavior (and therefore equilibrium values of ρ_i) is generically unique even when $\alpha = 0$.

willing to report honestly is zero. Because any time (i,t) makes a report in M with positive probability under $s'(\cdot)$, (i,t) must make a report in M with probability one under $s''(\cdot)$, the claim follows. Inequality (11) implies that for at least one $k \in M, r'_k \leq r''_k$. By Proposition 1, it follows that $\rho'_k \geq \rho''_k$, and hence $\rho'_i \geq \rho''_i$ for all i. Because we can use the same argument reversing the roles of the two equilibria, it follows that $\rho'_i = \rho''_i$ for all i. ∎

Equilibrium may not be unique. Consider the special case in which $c(i,j) = 0$. In this case, all agents have identical preferences over lies. If equilibrium involves $\rho_k < 1$ for more than one value of k, then there will typically be different signaling strategies compatible with equilibrium. Nevertheless, Lemma 1 guarantees that the conditional probability of a lie given the observed value and the conditional probability of a report being honest are uniquely determined in equilibrium.

Let s be an equilibrium and let

$$L(s) = \{k : \text{ there exists } i \neq k \text{ and } t, \text{ such that } s(k \mid i,t) > 0\}.$$

Here, $L(\cdot)$ is the set of claims that are made dishonestly with positive probability in equilibrium. Note that $\rho_k(s) < 1$ if $k \in L(s)$ and, by Proposition 1, $\rho_k(s) = 1$ if $k \notin L(s)$, so $L(s) = \{k : \rho_k(s) < 1\}$.

PROPOSITION 3: *The highest claim is made dishonestly with positive probability.*

PROOF:

Recall that N is the highest value. If $N \notin L(s)$, then $\rho_N(s) = 1$ and $W_N - W_{N-1} \geq v_N - v_{N-1}$. Because $c(N-1,N) < v_N - v_{N-1}$ by assumption, for t sufficiently small $W_N - C(N-1,N,t) > W_{N-1}$, so an $(N-1,t)$ agent would prefer to dishonestly report N than to tell the truth. Because Corollary 1 implies that a dishonest agent will never underreport, the result follows. ∎

Proposition 3 demonstrates that maximal lies (reporting N) occur with positive probability. When social identity matters, partial lies will occur in equilibrium. That is, N will not be the only claim reported dishonestly under intuitive conditions.

PROPOSITION 4: *Suppose* $N > 2$ *and* $v_{N-1} - v_{N-2} > c(N-2,N-1)$. *If either*

(*i*) $\alpha > v_N - v_{N-1}$ *and* p_N *is sufficiently small or*

(*ii*) α *is sufficiently high,*

then N is not the only claim made dishonestly with positive probability.

PROOF:

We show $L(s) = \{N\}$ is not possible if the conditions in the proposition hold. If $L(s) = \{N\}$, then $\rho_k(s) = 1$ for $k < N$ and $(N-2, t)$ must report either $N-2$ or N. Consequently, for all t,

$$\max\{v_{N-2} + \alpha, v_N + \alpha\rho_N - C(N-2, N, t)\} \geq v_{N-1} + \alpha - C(N-2, N-1, t). \tag{12}$$

Because $v_{N-1} - v_{N-2} > c(N-2, N-1)$, there exists $\tilde{t} > 0$ such that if $t < \tilde{t}$,

$$v_{N-1} + \alpha - C(N-2, N-1, t) > v_{N-2} + \alpha. \tag{13}$$

It follows from (12) that

$$v_N + \alpha\rho_N - C(N-2, N, t) \geq v_{N-1} + \alpha - C(N-2, N-1, t), \tag{14}$$

and that the probability that $N-2$ reports N is at least $F(\tilde{t}) > 0$ for all α and p_N. Consequently, there exists $b < 1$ such that $\rho_N < b$. We now have a contradiction: when Condition (1) holds, ρ_N must converge to 0 and (14) contradicts $\alpha > v_N - v_{N-1}$; when Condition (2) holds, (14) cannot hold if α approaches infinity. ∎

Propositions 3 and 4 require conditions on $v_k - v_{k-1}$. Without assumptions on the rate of increase of the rewards, some claims may not be worth lying for. For the next result, we impose a stronger condition: $v_k - v_{k-1} > c(k-1, k)$ for all k. In many experimental designs, $v_k - v_{k-1}$ is a positive constant. This condition holds in the models of Dufwenberg and Dufwenberg (2017) and Khalmetski and Sliwka (2016). Clearly, if $v_k > v_{k-1}$ and $c(k-1, k) = 0$, then $v_k - v_{k-1} > c(k-1, k)$. This assumption adds structure to the equilibrium.

PROPOSITION 5: *Suppose $v_k - v_{k-1} > c(k-1, k)$ for all k. There exists $n^* < N$ such that $L(s) = \{k : k > n^*\}$.*

Note, $L(s) = \{k : k > n^*\}$ is equivalent to $\rho_k < 1$ for $k > n^*$ and $\rho_k = 1$ for $k \leq n^*$.

PROOF:

Let $n^* = \max\{k : \rho_k = 1\}$. It follows from Proposition 2 that $\rho_1 = 1$, so n^* is well defined. We must show $\rho_k = 1$ for $k \leq n^*$. We know that $\rho_{n^*} = 1$. Assume that $\rho_k = 1$ for $k = k^*, \ldots, n^*$ and $k^* > 1$. The condition

$$v_j - v_{j-1} > c(j-1, j) \quad \text{for all } j \tag{15}$$

implies that for t sufficiently small, $(k^* - 1, t)$ strictly prefers to report k^* to $k^* - 1$. Hence, by Corollary 1, $\rho_{k^*-1} = 1$, which establishes the result. ∎

When $\alpha = 0$, the conclusion of Proposition 5 is stronger. Condition (15) and the maintained assumption that $c(i, k-1) + c(k-1, k) \geq c(i, k)$ implies that

$v_k - v_{k-1} > c(i,k) - c(i,k-1)$. Consequently, (15) implies that $v_k - C(i,k,t) > v_{k-1} - C(i,k-1,t)$. Hence, in the observed game, any agent who lies reports N and so no partial lies occur in the observed game ($n^* = N-1$) when (15) holds.

Proposition 5 states that a cutoff observation exists. If the outcome is above this cutoff, then agents never lie. If the outcome is below the cutoff, then they lie with positive probability and dishonest claims are above the cutoff.

If agents care about their social identity, then the prior distribution over outcomes should influence behavior in a systematic way. In particular, if the prior distribution shifts mass from the most likely profitable outcome N to lower outcomes, telling the biggest lie should become less attractive. The next result formalizes this intuition. We consider a simple shift of probabilities: The distribution $p'' = (p''_1, \ldots, p''_N)$ is a *proportional shift from* N of $p' = (p'_1, \ldots, p'_N)$ if there is $\lambda \in (0,1)$ such that $p''_N = \lambda p'_N$ and $p''_i = (1 - \lambda p'_N) p'_i / (1 - p'_N)$ for $i < N$.

The next proposition is our key comparative-statics result. Compare a situation in which the observed outcomes are ex ante equally likely to one in which the observation giving the highest reward is extremely unlikely. In the second case, if all dishonest agents make the highest claim, then lower social identity would result. If being viewed as honest is sufficiently valuable, then dishonest agents would prefer to make a smaller claim, losing some monetary payment, but gaining a stronger social identity for being honest.

PROPOSITION 6: *Suppose* $v_k - v_{k-1} > c(k-1,k)$ *for all* k. *Let* p'' *be a proportional shift from* N *of* p'. *Let* s' (s'') *be an equilibrium associated with a prior probability distribution* p' (p''). *For each* i, $\rho'_i \geq \rho''_i$, $L(s') \subset L(s'')$, *and for all* $k < N$, *the probability of a dishonest report of* k *is at least as great under* p'' *as under* p'.

Three conclusions follow from Proposition 6. The first conclusion is that shifting prior probability to less valuable outcomes lowers the probability that any claim is viewed as honest. Hence, a proportional shift from N lowers the utility of the agent. It is intuitive that the shift should lower ρ_N. If p'' is a proportional shift from p', then $\rho'_N < \rho''_N$ suggests reporting N under p'' is more attractive than under p', which implies $\rho'_N \geq \rho''_N$, which is a contradiction. The second conclusion is that more claims are made dishonestly under s'' than under s'. Thus, shifting probability from N makes the subject willing to dishonestly report lower claims. Because a cutoff observation exists (by Proposition 5), shifting probability from N lowers the lowest value that is reported dishonestly. Loosely, the social identity loss associated with higher claims could be large enough to convince the subject to make a more modest lie. The third claim is that the probability of partial lies (reports that are both dishonest and less than N) increases after a proportional shift. One reason for this change is non strategic. If p'' is a proportional shift of p', then there is more prior probability on low outcomes. Hence, there are more situations under which lying is attractive. The conclusion depends on more than this observation. The first conclusion implies that an agent's social identity will be lower after the proportional shift. The lower social identity decreases the incentive to lie (and acts against the third conclusion). Further, some of the lies are maximal lies. There might be more lies under p'', but not more partial lies.

One might conjecture that a proportional shift from N would lead to a reduction in the fraction of maximal lies. We cannot establish this property. Because the proportional shift creates more possible lies (since a larger fraction of outcomes is less than N) the ex ante fraction of maximal lies might increase even as the payoff of these lies decreases. Hence an asymmetry exists between claims of N and claims of $k < N$. The reason for this asymmetry is that if a smaller fraction of subjects dishonestly report $k < N$ under p'' than under p', then $\rho''_k > \rho'_k$, because $p''_k > p'_k$, whereas $\rho'_N \geq \rho''_N$ is possible even if a smaller fraction of subjects dishonestly report N under p'' than under p', because $p'_N > p''_N$.

PROOF:

Let l'_{ik} (l''_{ik}) be the conditional probability that an agent who observes i dishonestly reports k under p' (p''). Hence, $r'_k = \sum_{i=1}^{N-1} p'_i l'_{ik}$ and $r''_k = \sum_{i=1}^{N-1} p''_i l''_{ik} = (1 - \lambda p'_N) \sum_{i=1}^{N-1} p'_i l''_{ik} / (1 - p'_N)$ by the definition of p'' (note that because $l_{NN} = 0$, there is no term involving $p_N l_{NN}$).

If k is reported dishonestly, then no one who observes k lies, so $h_k = p_k$ by Proposition 1. Otherwise, $h_k \geq p_k$. It follows that if k is claimed dishonestly under s', if $k < N$, then

$$r'_k / p'_k \leq r''_k / p''_k \text{ implies } \rho'_k \geq \rho''_k. \tag{16}$$

If k is not claimed dishonestly under s', then $\rho'_k = 1$. It follows that (16) holds for all k. The same argument (using s'') permits us to conclude that

$$\text{if } k < N, \quad \text{then } r'_k / p'_k \leq r''_k / p''_k \text{ if and only if } \rho'_k \geq \rho''_k. \tag{17}$$

The definition of ρ_N implies

$$\rho'_N \geq \rho''_N \quad \text{if and only if} \quad \sum_{i=1}^{N-1} p'_i l'_{iN} \leq \frac{(1 - \lambda p'_N) \sum_{i=1}^{N-1} p'_i l''_{iN}}{\lambda (1 - p'_N)}. \tag{18}$$

Because $\lambda(1 - p'_N) \leq 1 - \lambda p'_N$, it follows from inequalities (17) and (18) that $\rho'_k \geq \rho''_k$ if

$$\sum_{i=1}^{N-1} p'_i l'_{ik} \leq \sum_{i=1}^{N-1} p'_i l''_{ik}. \tag{19}$$

Let M be the set of minimizers of $\rho'_j - \rho''_j$. If

$$W'_k - C(i,k,t) \geq W'_j - C(i,j,t),$$

then $W''_k - C(i,k,t) + \alpha\big((\rho''_j - \rho'_j) - (\rho''_k - \rho'_k)\big) \geq W''_j - C(i,j,t)$. Hence if $k \in M$, then $W''_k - C(i,k,t) \geq W''_j - C(i,j,t)$ with strict inequality unless $j \in M$. It follows that if $s'(k \mid i,t) > 0$ for $i \neq k, k \in M$, then $s''(j \mid i,t) = 0$ for all $j \notin M, j \neq i$. Because the set of t such that $i \in M$ and (i,t) is indifferent between reporting i and $k \neq i$ has measure zero, it follows that $\sum_{k \in M} l'_{ik} \leq \sum_{k \in M} l''_{ik}$ and therefore

$$\sum_{i=1}^{N-1} \sum_{k \in M} p'_i l'_{ik} \leq \sum_{i=1}^{N-1} \sum_{k \in M} p'_i l''_{ik}.$$

It follows that inequality (19) holds for at least one $k \in M$ and therefore that $\rho'_k \geq \rho''_k$ for some $k \in M$. By the definition of M, it must be that $\rho'_j \geq \rho''_j$ for all j. This establishes the first part of the proposition. The inclusion $L(s') \subset L(s'')$ follows from the definition of L and Proposition 1. Because $p'_k \leq p''_k$ for $k < N$, inequality (17) implies that there are at least as many partial lies to k, under p'' as under p' for all k. ∎

Proposition 6 describes what happens if one shifts probability from the most attractive observation. It demonstrates that such a shift increases the fraction of partial lies. Is this qualitative feature a consequence of the highest state having low absolute probability (p_N small) or low relative probability (p_i/p_N large for $i < N$)? Proposition 4 suggests that reductions in the absolute probability of the most attractive outcome lead to increases in the fraction of partial lies. The next proposition confirms this observation. For the proposition, we compare two environments. In one, the outcome is uniformly distributed over $1, 2, \ldots, N$. In the second, we permit observations that are not integers and, specifically, that the outcome is uniformly distributed over $0.5, 1, \ldots, N - 0.5, N$. Hence, one moves from the first environment to the second by doubling the number of possible observed outcomes.[13]

PROPOSITION 7: *Suppose* $v_k - v_{k-0.5} > c(k - 0.5, k)$ *for all* $k = 1, 1.5, \ldots, N$. *Let* p' *be a uniform distribution on* $\{1, 2, \ldots, N\}$ *and let* p'' *be a uniform distribution on* $\{0.5, 1, \ldots, N\}$. *Let* s' (s'') *be an equilibrium associated with a prior probability distribution* p' (p''). *For each* $i = 1, \ldots, N$, $\rho'_i \geq \rho''_i$ *and* $L(s') \subset L(s'')$. *The probability of a partial lie is greater under* p'' *as under* p'.

The conclusion that $L(s') \subset L(s'')$ means that splitting observed outcomes lowers the lowest value that is reported dishonestly. For example, if observations 8, 9, and 10 are reported dishonestly when $N = 10$, then when observed outcomes are split, we would expect to see dishonest reports of 7.5, 8, 8.5, 9, 9.5, and 10.

If the only dishonest claim made is $\{N\}$ (that is, $L(s'') = \{N\}$), then more agents might report this claim dishonestly under p'' because the probability of an observation less than N is greater under p'' than under p'. This possibility could happen if α is so low that nearly all agents make the maximum lie. In general, we cannot rule out the possibility that maximal lies are more common under p'' for the same reason we could not do so in Proposition 6: Under p'', outcomes less than N are more common and hence there is a higher ex ante probability of lying (and, perhaps, maximal lying).

Proposition 7 states that splitting observed outcomes lowers the threshold below which subjects lie. That is, $\rho'_i \leq \rho''_{i-1}$ and if $L(s') = \{k : k \geq n^*\}$ then $L(s'') \subset \{k : k \geq n^* - 1\}$. A careful examination of the argument demonstrates that when observed outcomes are split, reports need not change by more than one unit. That is, if (i, t) reports k prior to the split, then (i, t) would report k or $k - 0.5$ after the split.

Proposition 7 requires a preliminary result, which gives conditions under which social identity is weakly decreasing.

[13] The proposition uses a specific notion of splitting that is consistent with our experimental design.

LEMMA 2: *Suppose* $v_j - v_{j-1} > c(j-1,j)$ *for all* j. *Social identity is weakly decreasing in report. That is, if* $k' > k$, *then* $\rho_{k'} \leq \rho_k$.

PROOF:

Proposition 5 implies that there exists n^* such that $\rho_j = 1$ if and only if $j \leq n^*$. We claim that if $j \geq n^*$, then $\rho_{j+1} < \rho_j$. This claim is sufficient to prove the proposition. The claim is true when $j = n^*$. When $N > j > n^*$, there must be a type (i,t) that dishonestly reports j. Hence, j solves $\max_k W_k - C(i,k,t)$ and, in particular,

$$W_j - C(i,j,t) \geq W_{j+1} - C(i,j+1,t), \tag{20}$$

which implies

$$\begin{aligned}\alpha(\rho_j - \rho_{j+1}) &\geq v_{j+1} - v_j + c(i,j) - c(i,j+1)\\ &> c(j,j+1) + c(i,j) - c(i,j+1) \geq 0,\end{aligned}$$

where the first inequality follows from (20), the second inequality by $v_{j+1} - v_j > c(j,j+1)$, and the third by the maintained assumption on $c(\cdot)$. It follows that $\rho_j > \rho_{j+1}$, which establishes the result. ∎

We commented earlier that $v_j - v_{j-1} > c(j-1,j)$ for all j implies no partial lies arise when $\alpha = 0$. A stronger version of Lemma 2 holds in this situation: $\rho_k = 1$ for $k < N$ and $\rho_N < 1$.

PROOF OF PROPOSITION 7:

Let l'_{ik} (l''_{ik}) be the conditional probability that an agent who observes i dishonestly reports k under p' (p''). Hence, $r'_k = \sum_{i=1}^{N-1} l'_{ik}/N$ and $r''_k = \sum_{j=1}^{2N-1} l''_{(j/2)k}/2N$. If k is reported dishonestly, then no one who observes k lies, so $h_k = p_k$ by Proposition 1. Because $\rho_k = 1$ if k is not claimed dishonestly under s, $\rho'_k \geq \rho''_k$ if and only if $r'_k \leq 2r''_k$. That is,

$$\rho'_k \geq \rho''_k \quad \text{if and only if} \quad \sum_{i=1}^{N-1} l'_{ik} \leq \sum_{j=1}^{2N-1} l''_{(j/2)k}. \tag{21}$$

Extend the definition of ρ'_i for $i = (2m+1)/2$ and $m = 0, \ldots, N-1$ so that $\rho'_i = \rho'_{i+0.5}$. With this specification, no type would wish to make a report of the form $(2m+1)/2$. Let M be the set of minimizers of $\rho'_j - \rho''_j$. If

$$W'_k - C(i,k,t) \geq W'_j - C(i,j,t),$$

then $W''_k - C(i,k,t) + \alpha\big((\rho''_j - \rho'_j) - (\rho''_k - \rho'_k)\big) \geq W''_j - C(i,j,t)$. Hence if $k \in M$, then $W''_k - C(i,k,t) \geq W''_j - C(i,j,t)$ with strict inequality unless $j \in M$. It follows that if $s'(k\,|\,i,t) > 0$ for $i \neq k, k \in M$, then $s''(j\,|\,i,t)/0$ for all $j \notin M, j \neq i$.

Because the set of t such that $i \in M$ and (i,t) is indifferent between reporting i and $k \neq i$ has measure zero, it follows that $\sum_{k\in M} l'_{ik} \leq \sum_{k\in M} l''_{ik}$ and therefore

$$\sum_{i=1}^{N-1} \sum_{k\in M} l'_{ik} \leq \sum_{j=1}^{2N-1} \sum_{k\in M} l''_{(j/2)k} \tag{22}$$

and for at least one $k \in M$,

$$\sum_{i=1}^{N-1} l'_{ik} \leq \sum_{j=1}^{2N-1} l''_{(j/2)k}. \tag{23}$$

It follows from inequalities (21) and (23) that $\rho'_k \geq \rho''_k$ for some $k \in M$. By the definition of M, it must be that $\rho'_j \geq \rho''_j$ for all $j = 1, 2, \ldots, N$. Consequently, inequality (21) implies inequality (23) holds for all k. This establishes the first part of the proposition. The inclusion $L(s') \subset L(s'')$ follows from the definition of $L(\cdot)$ and Proposition 1. To complete the proof it suffices to show that for $i < N$,

$$\frac{1}{N} \sum_{k=2}^{N-1} \sum_{i=1}^{N-1} l'_{ik} \leq \frac{1}{2N} \sum_{k=2}^{2N-1} \sum_{j=1}^{2N-2} l''_{(j/2)(k/2)}.$$

Lemma 2 implies that if $k' < k$, then $\sum_{j=1}^{2N-1} l''_{(j/2)k'} \leq \sum_{j=1}^{2N-1} l''_{(j/2)k}$. In particular, this inequality holds when $k' = k - 0.5$. Using inequality (23), we conclude that

$$\frac{1}{N} \sum_{k=2}^{N-1} \sum_{i=1}^{N-1} l'_{ik} \leq \frac{1}{N} \sum_{k=2}^{N-1} \sum_{j=1}^{2N-1} l''_{(j/2)k} \leq \frac{1}{2N} \sum_{k=2}^{2N-1} \sum_{j=1}^{2N-2} l''_{(j/2)(k/2)},$$

which is the desired result. ∎

Let us further specialize the model and assume $v_i - v_{i-1} \equiv \nu$, where ν is a positive constant and $c(i,j) = d(j-i)$ depends on the difference between the reported state and the true state.

PROPOSITION 8: *Suppose* $v_k - v_{k-1} > c(k-1,k)$ *for all* k *and* $v_i - v_{i-1} \equiv \nu > 0$ *for all i. The probability of an honest report is a non-increasing function of the observed value.*

PROOF:

It suffices to show that if $j > i$ and type (j,t) dishonestly reports k, then type (i,t) prefers to report $k - j + i$ rather than to tell the truth. That is, if

$$W_k - d(k-j) - t \geq v_j \text{ implies } W_{k-j+i} - d(k-j+i-i) - t \geq v_i. \tag{24}$$

Implication (24) follows because

$$W_k - v_j = v_k - v_j + \alpha r_k = v_{k-j+i} - v_i + \alpha r_k$$

$$\geq v_{k-j+i} - v_i + \alpha r_{k-j+i} = W_{k-j+i} - v_i,$$

where the first and last equations are definitions, the second equation follows because $v_k - v_j = (k-j)\nu = v_{k-j+i} - v_i$ and the inequality follows from Lemma 2. ∎

We conclude this section with a discussion of related papers.

Abeler, Nosenzo, and Raymond (forthcoming) discuss a variety of models for an environment in which there are two possible outcomes and two possible reports. The models include preferences in which making a dishonest report lowers utility and in which agents' utility is increasing in their reputation for honesty, a force that operates similarly to our likelihood dimension. They find that models that include both of these features help organize experimental data. The model of Abeler, Nosenzo, and Raymond (forthcoming) permits underreporting in equilibrium. Underreporting is ruled out in our model in equilibrium by Proposition 2.[14]

Dufwenberg and Dufwenberg (2017) study a model in which the agent's preference depends on the claim and a term similar to our social identity term. The term is proportional to an observer's expectation of the difference (if positive) between the claim and the observed value. In our model, the likelihood term is proportional to the probability that the report is honest. Hence, in their model, the social identity cost of making a dishonest report may depend on the level of dishonesty.[15] There is at least one important implication of this difference in assumptions: Dufwenberg and Dufwenberg show by example that Propositions 1 and 5 do not hold in their model. Their model typically exhibits multiple, qualitatively different equilibria, although they provide reasons to focus on a particular equilibrium. Similar to us, Dufwenberg and Dufwenberg show that partial lies are possible in equilibrium.

Khalmetski and Sliwka (2016) analyze a special case of our model in which $c(i,j) = 0$ (they also assume that the prior distribution is uniform). This specialization permits them to fully characterize the unique symmetric equilibrium of the model. Whereas they focus on comparative statics with respect to the value of reputation (α), they identify some of the same important qualitative properties that we do.

In Dufwenberg and Dufwenberg (2017) and Khalmetski and Sliwka (2016) there is indifference across many possible lies. For this reason, randomization is essential in the construction of equilibrium. If k and k' are claimed dishonestly in equilibrium, then anyone who claims k dishonestly in equilibrium will obtain the same utility by claiming k'. In our most general specification, if $k \neq k'$, then type (k,t) may strictly prefer to make a different dishonest report than type (k',t). Nevertheless, our assumptions do imply that if two agents observe the same k and make different dishonest reports, then they must be indifferent between these reports. That is, type (k,t) and type (k,t') have the same preferences over lies for every k (although if $t' > t$, then (k,t) might prefer to report honestly when (k,t') prefers to lie). This

[14] Abeler, Becker, and Falk (2014) find small, but statistically significant evidence for underreporting in an unobserved game. Utikal and Fischbacher (2013) find evidence of under reporting. Utikal and Fischbacher find that no one reports the two (out of six) highest outcomes. Their sample size is small (12 observations) and their subject pool (nuns) may be atypical.

[15] Dufwenberg and Dufwenberg (2017) assume that agents have identical preferences and there is no direct cost of lying. It our notation, they assume $C(\cdot) \equiv 0$.

observation follows from the assumption that the fixed cost of lying enters additively in $C(\cdot)$.

Garbarino, Slonim, and Villeval (2016) analyze a model in which there are two possible observations and argue that reference dependence and loss aversion may influence lying behavior. In particular, they show that agents are more likely to dishonestly report the good outcome when the prior probability of the good outcome increases. This result is similar to our findings on the effect of varying the prior distribution of observed outcomes.[16]

III. Hypotheses

This section describes testable implications of the theory. The results section below will be based on these hypotheses. We note which hypotheses refer to the non-observed game or observed game. If nothing is noted, it means the hypothesis holds in both games.

HYPOTHESIS 1: *If some type lies by reporting k, then no type with true value k lies.*

Hypothesis 1 is a consequence of Proposition 1.

HYPOTHESIS 2: *No agent underreports.*

Hypothesis 2 is a consequence of Proposition 2.

HYPOTHESIS 3: *The highest claim is made dishonestly with positive probability.*

Hypothesis 3 is a consequence of Proposition 3.

HYPOTHESIS 4: *In the non-observed game, when social identity concerns are strong enough, some agents will lie partially.*

Hypothesis 4 is a consequence of Proposition 4.

HYPOTHESIS 5: *There exists a threshold of true values, below which there are lies with positive probability, above which there are no lies.*

Hypothesis 5 is a consequence of Proposition 5.

It follows from Hypotheses 1–3 and 5 that our model predicts the number of reports of a k will be below the actual number of times the true value is k up to a

[16] Unlike Abeler, Nosenzo, and Raymond (forthcoming); Dufwenberg and Dufwenberg (2017); Khalmetski and Sliwka (2016); and this paper, Garbarino, Slonim, and Villeval (2016) do not assume that preferences depend on beliefs about the honesty of a report. Garbarino, Slonim, and Villeval run double-blind experiments and argue that the social identity effect that we discuss should not influence payoffs when subjects know they are not being observed. We do not find this argument convincing for three reasons. First, our data allows us to compare observed to non-observed games. Observability matters in a way that loss aversion alone does not capture. Second, our model permits the social identity motive to be internal. Doing something that would appear dishonest even if she knows no one would find out may be costly to an agent. Her motive is to reinforce her social identity as an honest person. Third, agents may mistakenly believe others know what they know.

cutoff for $k \leq k^*$ and the number of reports of k to be above the true number for $k > k^*$.

HYPOTHESIS 6: *In the non-observed game*, *an increase in the probability that the true type is less than the highest type increases the number of values reported dishonestly and the probability of partial lies.*

Hypothesis 6 is a consequence of Proposition 6.

The next hypothesis compares equilibria of a situation in which there are N equally likely, equally spaced, outcomes to one in which there are $2N$ equally likely, equally spaced, outcomes (with new outcomes inserted between old ones) as discussed in Proposition 7.

HYPOTHESIS 7: *In the non-observed game*, *increasing the number of states increases the range of the values that are reported dishonestly and increases the probability of partial lies.*

Hypothesis 7 states that splitting states lowers the cutoff that determines the lowest claim that would be made dishonestly. It is a consequence of Proposition 7.

HYPOTHESIS 8: *The lower the true value*, *the higher the fraction of dishonest reports.*

Hypothesis 8 is a consequence of Proposition 8.

IV. Experimental Design and Procedure

To test the hypotheses, we introduce two types of games, which we call *observed* and *non-observed* games.

A. *Observed Game*

The observed game is a variation of a cheating game in which we can observe ex post the individual lying behavior. In this game, we ask participants to click, in private, on one of ten boxes on a computer and reveal an outcome. We use three different observed game variations. In the Numbers treatment, the outcomes behind the ten boxes are numbers between one and ten, where each box has a different number and payment is equal to the number reported in euros.[17] After seeing the number, the participant is asked to report it to the experimenter. In this treatment, we know how often and to what extent participants lie because we can later observe the actual number each participant saw and compare it to the number s/he reported.

[17] Both the subject and the experimenter know that the numbers vary between one and ten. Neither our model nor the experiments consider what happens in asymmetric-information cases in which the subject has private information regarding the outcome space itself. Consider, for example, a game in which it is common knowledge that the observer believes the die is a standard six-sided die, but the subject knows in fact that the die has no six. Would the agent be more or less likely to lie in such a treatment than in the baseline setting with symmetric information? We leave testing of this situation for future research.

As discussed earlier, lying costs may depend on the distance between what the subject observes and what the subject says (outcome dimension). In the Numbers treatment, there is a natural and common measure of the distance between observed outcomes and reports. For example, if the participant observes a "four" and reports "ten," her report is six units from the truth. Lying costs may depend on this distance.

Another possibility is that lying costs depend on the payoff gained by the report relative to what the participant would earn if she reports honestly (payoff dimension). In the Numbers treatment, payoffs are linked directly to outcomes so one cannot distinguish the outcome dimension from the payoff dimension. The second treatment, Numbers Mixed, is designed to separate the reported outcome dimension from the payoff dimension. This treatment is similar to the Numbers treatment, but the ten numbers are assigned to the ten payoffs in a random order. Appendix Table A1 presents the assignment we defined in a random draw.

In the third observed treatment, Words, there is no natural ordering of the outcomes independent of payoffs. In this treatment, participants are asked to click on one of ten boxes in private and are told that the outcomes behind the boxes are ten Lithuanian words; each box has a different word. The words have payoffs between one and ten euros assigned to them, as presented in Appendix Table A2. There is no natural notion of distance in the outcome dimension because none of the participants knows Lithuanian and the words appear to be similar six-letter strings. Participants may distinguish between reporting truthfully or not, but we assume that the "outcome cost" of reporting (the Lithuanian word) "stirna" when the outcome is "vilkas" is the same as the outcome cost of reporting "kiskis" when the outcome is "vilkas." More generally, we assume that the outcome cost is zero for honest reports and the same for all dishonest reports.

B. *Non-Observed Games*

As discussed in Sections I and III, a participant might care about how she is perceived. When the experimenter does not observe the outcomes, the participant may refrain from reporting the highest number to signal she is not a liar.

In the Basic non-observed treatment, we give the participant a sealed envelope with ten folded pieces of paper that have numbers from one to ten on them. We ask the participant to take out one piece of paper, observe the number, put it back into the envelope, and then report it. As in the observed treatment, payments are equal to the number reported in euros. However, in contrast to the observed game, the experimenter can never know the actual outcome. If social identity concerns affect the lying decision, we would expect more participants to lie and/or a higher fraction of participants to partially lie in the non-observed than in the observed game. Lying costs that depend only on payoffs and outcomes could not explain a difference in behavior between the observed and non-observed games.

The model predicts that decreasing the prior probability of the highest outcome affects the number of values reported dishonestly. In the Low Probability non-observed treatment, we give the participants a sealed envelope with 100 folded pieces of paper that have numbers from 1 to 10 on them. We inform them that 11 pieces of paper have the number "one" on them, 11 pieces have the number "two" on them, and so on until "nine." Finally, one piece of paper has the number "ten"

on it. As in the Basic non-observed treatment, the payments are equal to the number reported in euros. Guided by the model's predictions, we expect subjects to report a higher range of values, because the chance of drawing a ten is only 1 percent, as opposed to 10 percent in the Basic non-observed treatment. If the prior distribution of outcomes influences reports, then outcome/payoff lying costs are insufficient to understand data.

In the final treatment (100-States non-observed treatment) we investigate the robustness of the predictions in the Low-Probability treatment. In this treatment, we give participants a sealed envelope with 100 pieces of paper with numbers between 1 and 100 on them and inform them that each piece of paper has one of the numbers on it. Participants receive the equivalent in euros to the number they report divided by ten. Whereas the probability of drawing 100 is the same as in Low-Probability treatment, all the other outcomes are equally likely. This treatment allows us to test whether the partial lying that we might observe in the Low-Probability treatment is the result of the difference in the relative probability of the highest state and lower states or is due to the fact that the absolute probability of the highest state is low.

C. *Experimental Procedure*

We conducted the experiments between April 2015 and April 2016 at the Cologne Laboratory for Economic Research, University of Cologne. We used the experimental software zTree (Fischbacher 2007) and recruited participants via ORSEE (Greiner 2015). Overall, we recruited 916 participants (55.9 percent female), and none of them participated in more than 1 session. We collected 102–390 observations per treatment. Participants played only our treatment in the experimental session with a session lasting approximately 30 minutes.[18]

After being randomized into a treatment, participants read the instructions on the computer screen, and were allowed to ask questions privately. Then, depending on the treatment, participants either received the envelopes with numbers and were asked to pick one, or were asked to click on one of the boxes on the computer screen and reveal the number. After observing the number, participants reported the outcomes on a sheet of paper and filled out a post-experiment questionnaire that included questions on gender, age, field of study, and motives behind their decisions. At the end, participants privately received their payoffs in cash and left the laboratory. Table 1 presents all of our treatments and the number of participants in each.

V. Results

In what follows, we first present the data from the observed treatments and then move to testing the hypotheses that are based only on the observed treatments (Hypotheses 1–3, 5, and 8). We then report the results from the non-observed treatments and the tests of the corresponding hypotheses (Hypotheses 4, 6, and 7).

[18] Experimental instructions are available as an online supplement.

Table 1—Summary of Treatments and Number of Participants in Each

Treatment	Number of participants
Observed	
Numbers	390 (54.9% female)
Numbers mixed	110 (62.7% female)
Words	102 (60.8% female)
Non-Observed	
Basic	103 (52.4% female)
Low probability	107 (52.3% female)
100-States	104 (54.8% female)

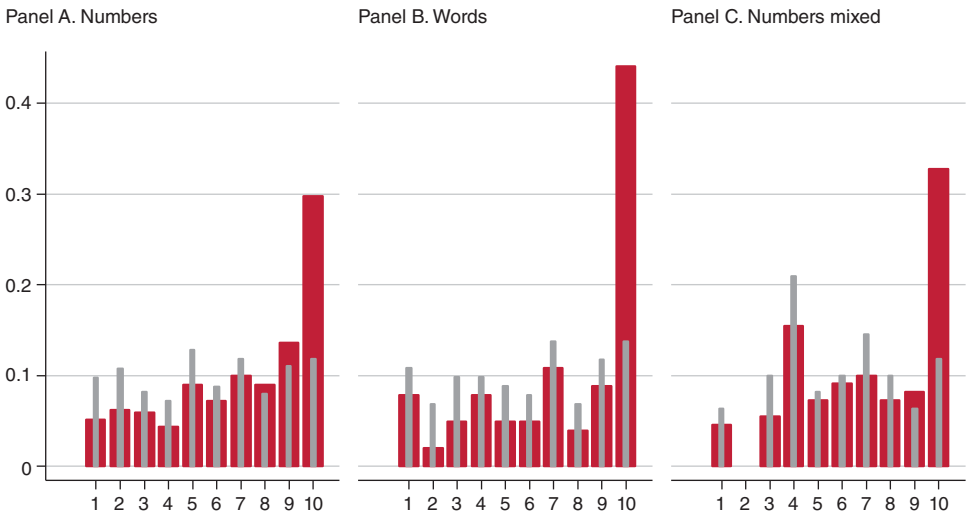

Figure 1. Distribution of Reported Payoffs in the Observed Treatments

Note: The thick dark bars show the reported payoffs, whereas the thin light gray bars show the actual payoffs.

A. *Observed Game*

We divide our discussion into two subsections. We first present the descriptive statistics and then discuss the relationship between behavior and the hypotheses.

Outcome and Payoff Dimensions in the Observed Game.—Figure 1 presents the distributions of actual and reported payoffs in the observed game and is the first indicator that the reported payoffs are higher than the actual payoffs resulting from the outcomes (numbers or words).

We find that in all the observed treatments the reported numbers are significantly higher than the observed outcomes with $p < 0.001$ (Wilcoxon Matched-Pairs Signed-Ranks Test).[19] Overall, 26 percent, 33 percent, and 27 percent of participants

[19] All tests in the paper are two sided. We call an effect highly significant, significant, or marginally significant if the test generates $p < 0.01$, $p < 0.05$, $p < 0.1$, respectively.

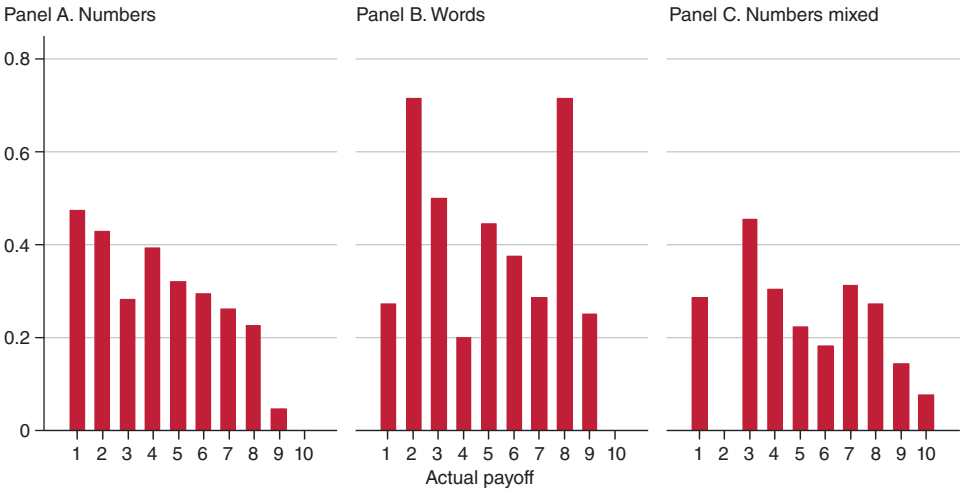

FIGURE 2. FRACTION OF LYING CONDITIONAL ON THE ACTUAL PAYOFF

lie in the Numbers, Words, and Numbers Mixed treatments, respectively. The overall level of lying is not significantly different between the treatments in pairwise comparisons using a Fisher exact test ($p > 0.1$).

The observed game also allows us to analyze the probability of lying conditional on the actual payoff observed, as presented in Figure 2. We can see from the figure that in the Numbers treatment, the lower the observed outcome is, the more likely participants are to lie. For example, only 5 percent of participants who observed a nine overreport their number, whereas 47 percent of the participants who observed a one did. The results show a significant negative correlation (Spearman's rho $= -0.318, p < 0.001$) between the payoff observed and the probability of lying. In the Words treatment there is also a negative correlation, but less strong than in the Numbers treatment (Spearman's rho $= -0.202, p = 0.042$). In the Numbers Mixed treatment, a marginally significant correlation exists between the actual payoff and the probability of lying (Spearman's rho $= -0.170, p = 0.079$).[20]

Another important feature of the observed treatment is that it allows us to know what payoff people who lie report. Figure 3 presents these data. We find no correlation between the actual and reported payoff when one lies (Spearman's rho $= 0.052, p = 0.601$ for the Numbers treatment; rho $= 0.188, p = 0.288$ for the Words treatment and rho $= -0.021, p = 0.914$ for the Numbers Mixed treatment). This finding is consistent with the models of Dufwenberg and Dufwenberg (2017) and Khalmetski and Sliwka (2016) that assume no variable costs of lying.[21]

The actual observed payoffs are not different between the treatments (i.e., the randomization worked; $p > 0.1$, MWU). The average reported payoff in the Numbers treatment is only marginally lower than in the Words treatment (7.02 versus 7.39,

[20] One person underreported in this treatment (observing ten and reporting four) and two did not click on any boxes and then reported a ten. The two participants who did not click are excluded in Figure 2 and in the Spearman's correlations, because they have no observed outcome. If the two participants are not excluded, Spearman's rho amounts to -0.213 with $p = 0.025$.

[21] If $c(i,k) < c(i,j) + c(j,k)$ in our model, then, conditional on lying, lower types would tell bigger lies than higher types.

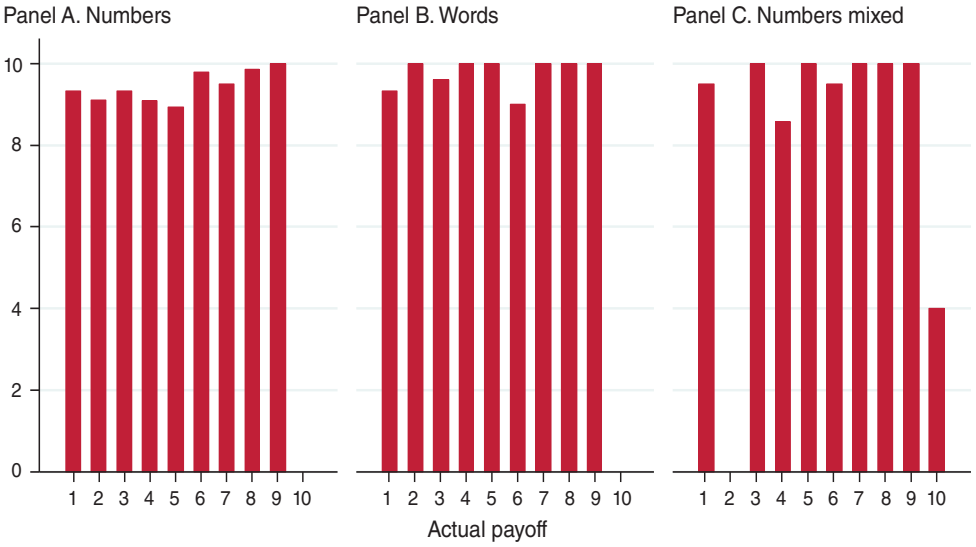

FIGURE 3. AVERAGE PAYOFFS REPORTED BY PARTICIPANTS WHO LIE

respectively; $p = 0.090$, MWU), and is not statistically different from the average reported payoff of 7.03 in the Numbers Mixed treatment ($p = 0.198$, MWU). The difference between the Numbers Mixed and Words treatments is also not statistically significant ($p = 0.205$, MWU). Thus, in the extensive margin, the reporting is not significantly different between the observed treatments.[22]

Next, Figure 4 and Appendix Figure A1 describe the payoffs reported by participants who lie. We observe that in the Numbers treatment, 68 percent of participants who lie, lie to the full extent by saying ten. This fraction is 91 percent in the Words treatment and 80 percent in the Numbers Mixed treatment. The fraction of participants who lie by reporting ten in the Words treatment is significantly higher than in the Numbers treatment ($p = 0.007$, Fisher exact test). The average payoff reported by participants who lie in the Words treatment, 9.80, is also significantly higher than the Numbers treatment (9.80 versus 9.32, respectively; $p = 0.011$, MWU). Thus, in the intensive margin, we find significant differences between lying behavior in the Words and Numbers treatments.

The difference between lying in the Words and the Numbers treatments suggests that the outcome dimension affects lying costs. Presumably, we observe less partial lying in the Words treatment because it lacks a clear notion of partial lying on the outcome dimension. This finding suggests that in the Numbers treatment some participants perceive reporting "eight" when observing "four" a smaller lie than reporting "ten." In contrast, in the Words treatment, reporting "alyvos" when observing "vilkas" has the same outcome cost as reporting "alyvos" when observing "stirna." However, the role of the outcome dimension on the extent of lying is relatively small, with only 8.45 percent of the participants (33 out of 390) lie partially in the Numbers treatment and the fraction decreases to 2.94 percent (3 out of 102) in the

[22] The extensive margin corresponds to the fraction of people who lie; the intensive margin corresponds to the size of the lie for people who choose to do so.

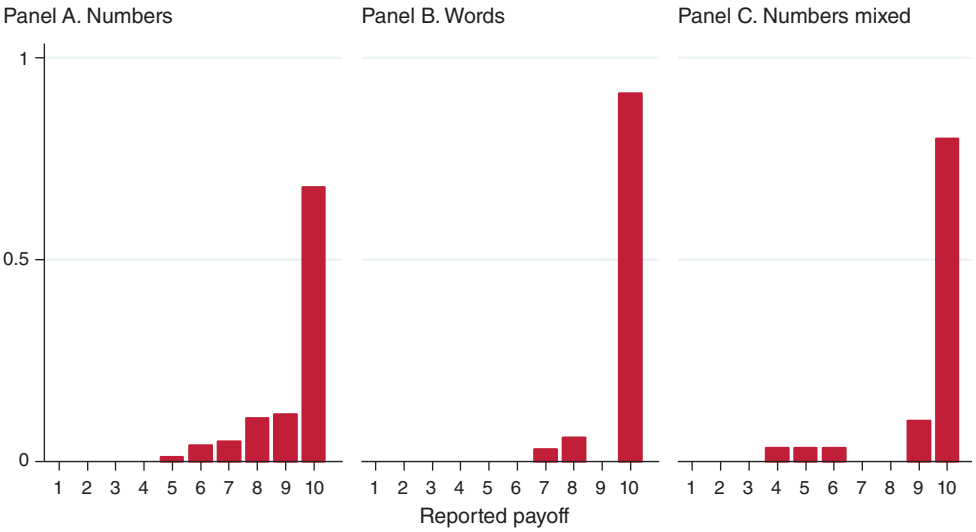

FIGURE 4. DISTRIBUTION OF PAYOFFS REPORTED BY THE PARTICIPANTS WHO LIE

Words treatment. In addition, as we showed previously, the effect on the extensive margin is not significant.

Consistent with our findings, Hilbig and Hessler (2013) also find evidence that the outcome dimension influences the cost of lying. They conduct an unobserved version of the Numbers treatment in which subjects roll a fair six-sided die and report the outcome. Subjects receive a prize if they report a pre-specified target outcome. Hilbig and Hessler find that there are more lies when the target is intermediate (three or four) than when it is extreme (one or six). This finding is consistent with the hypothesis that lying costs depend on the distance in the outcome dimension (because more observations are close to intermediate targets than to extreme targets).

The absence of partial lying in the Words treatment suggests that the payoff dimension has no effect on the cost of lying on the intensive margin. When observing an outcome that results in four euros if reported honestly, the cost of dishonestly reporting something that leads to a payoff of six euros does not appear to be significantly lower than the cost of dishonestly reporting something that leads to a payoff of eight euros.

In the Numbers Mixed treatment, the fraction of participants who lie is between the Numbers and Words treatments and is not significantly different from the two treatments ($p = 0.257$ and $p = 0.285$, Fisher exact test). The average payoff reported by participants who lie in the Number Mixed treatment is not significantly different from either the Words or the Numbers treatments (9.80 versus 9.32, respectively; $p = 0.205$ and $p = 0.250$, MWU).

Figure 5 shows the results for the Numbers Mixed treatment with respect to the outcome dimension. The results show that lying behavior in this treatment is not related to the outcome dimension—the decision to lie does not depend on the actual number observed (see Figure 5, panel B; Spearman's rho $= -0.157$, $p = 0.102$) and when participants lie, they lie mostly by reporting a "two," which results in a

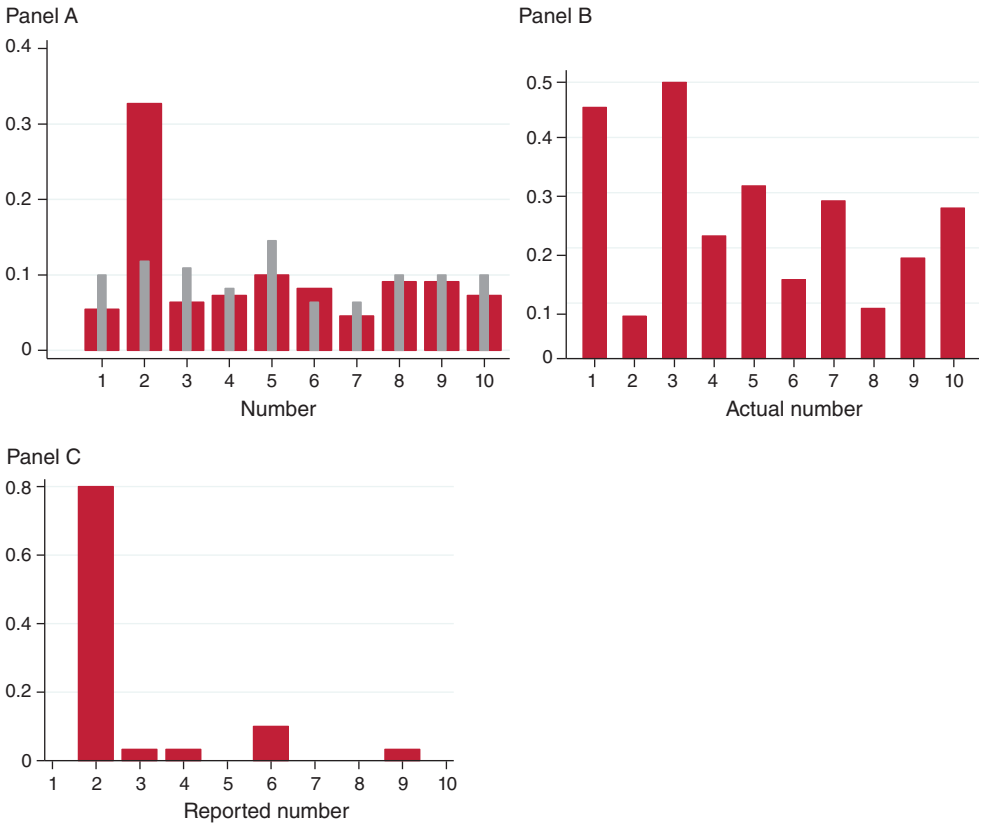

FIGURE 5. LYING IN THE NUMBERS MIXED TREATMENT WITH RESPECT TO THE NUMBER OBSERVED

Notes: Panel A presents the distribution of reported and actual numbers in the Numbers Mixed treatment. The thick dark bars show the reported numbers, whereas the thin light gray bars show the actual numbers. Panel B presents the fraction of lying conditional on the actual number. Panel C presents the distribution of numbers reported by the participants who lie.

payoff of ten (Figure 5, panels A and C). That is, when there is a trade-off between the outcome and payoff dimensions, participants lie according to the payoffs and neglect the outcome dimension.[23]

Based on the comparisons between the observed treatments, we conclude that the outcome dimension has a limited effect on the intensive margin and no effect on the extensive margin. We also conclude that the payoff dimension has no effect on the cost of lying on the intensive margin.

Hypothesis Testing.—The results from the observed treatments allow us to test Hypothesis 1, which states that if a participant observing k ever lies, then no one lies by saying k. As Figure 6 and Appendix Table A3 show, the results are generally

[23] We do not have a test of what happens if we change the payoffs associated with the decisions. For this reason, we cannot estimate the effect of the payoff costs on the extensive margin. Providing such a test is not trivial, because changing the payoffs would lead to changes in the behavior independent of the intrinsic lying cost (see Kajackaite and Gneezy 2017). We leave this exercise for future research.

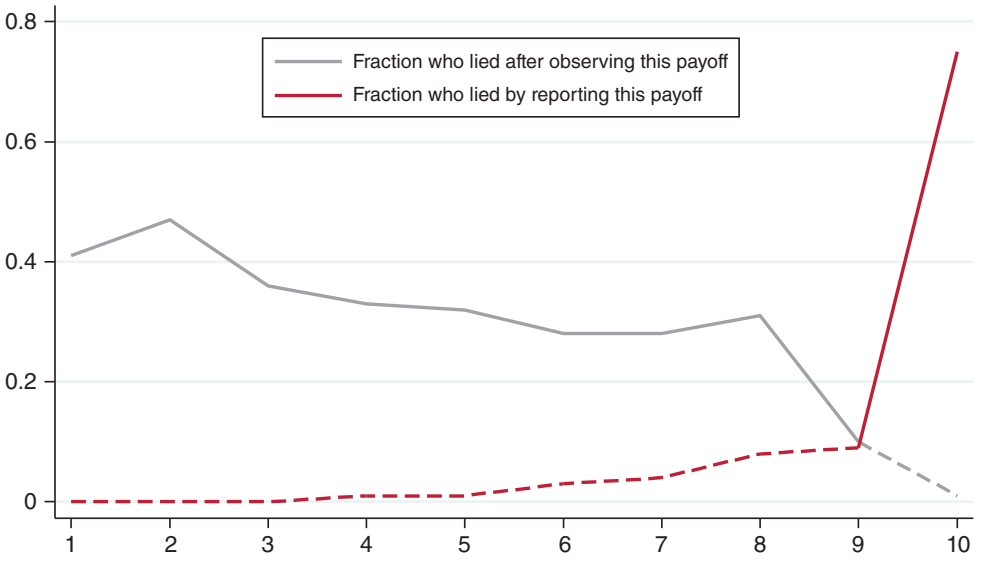

FIGURE 6. FRACTION OF PARTICIPANTS WHO LIE AFTER OBSERVING A PAYOFF VERSUS FRACTION OF PARTICIPANTS WHO LIE BY REPORTING THE PAYOFF

Notes: Solid lines denote the behavior which is in line with the theory. Dashed lines denote "mistakes."

consistent with this prediction. We use the pooled data from the observed game to count for deviations from the prediction with respect to the theory. We define a choice as a "mistake" if it violates Hypothesis 1 (i.e., if given that someone observing k lies, someone lies by reporting a k). Under this definition, mistakes are the minimum of the fraction who lie when observing the number and the fraction who lie by reporting the number. In Figure 6, the mistakes are marked with a dashed line. Lines 1–3 in (left side of the figure) contain no mistakes. Line 4 in Appendix Table A3 contains 1 mistake: participants lie after observing a 4 and 1 participant out of 167 (0.60 percent) lies by reporting 4. Lines 5, 6, 7, 8, and 9 contain 2, 5, 6, 13, and 15 mistakes, respectively (1.20 percent, 2.99 percent, 3.59 percent, 7.78 percent, and 8.98 percent out of 167 participants). Line 10 contains 1 mistake, because 1 person out of 73 (1.37 percent) observing a 10 lies downward.

Overall, we observe 43 mistakes for 602 participants (7.14 percent) in our data. We conclude the following result.[24]

RESULT 1: *The data show that if a participant observing k lies, then only a small fraction of participants lie by saying k.*

[24] We number the results parallel to the propositions and hypotheses, but we report them in a slightly different order. We hope that the reader will not be too alarmed to find that we report Result 5 immediately after Result 3. The patient reader will find Result 4.

Hypothesis 2 states that a participant would not underreport her payoff. This hypothesis is easy to test in our data. As we reported above, only 1 participant out of 602 underreported in our experiment. Therefore, we conclude Result 2.

RESULT 2: *Most participants* (99.83 *percent*) *do not underreport their payoffs.*

Hypothesis 3, which asserts that the highest claim is made dishonestly with a positive probability, is also supported by the data presented in Figure 3. In particular, we observe that of the people who lie, 68 percent, 80 percent, and 91 percent report the highest possible payoff in the observed treatments.

RESULT 3: *Of the participants who lie, a high fraction* (*an average of* 74.85 *percent*) *report the highest payoff.*

We find partial support for Hypothesis 5, that there exists a threshold of actual payoffs, below which there are lies with positive probability and above which there are no lies. In particular, in the observed treatments, 27.63–46.94 percent (an average of 34.26 percent) of participants lie when observing a payoff below nine, but only 9.68 percent and 1.37 percent lie after observing nine or ten, respectively (see Figures 2 and 6 and Appendix Table A3).

RESULT 5: *There is a threshold of actual payoffs of nine, below which there is a high fraction of lies* (*average* 34.26 *percent*), *and above which there are only few lies* (*average of* 5.19 *percent*).

In Figure 2, we report support for Hypothesis 8, which states that the lower the true value, the higher the fraction of dishonest reports. There is a significant negative correlation between the payoff observed and the probability of lying in the observed game.

RESULT 8: *There is a significant negative correlation between the payoff observed and the probability of lying in the observed game: The lower the actual payoff, the higher the fraction of dishonest reports.*

B. *Non-Observed Game*

Figure 7 presents the results from the non-observed treatments. The graphs show the distributions of the reported payoffs on the aggregate level and, as in the case of the observed treatments, indicate (this time only statistically) that reported payoffs are higher than expected payoffs; a Kolmogorov-Smirnov test confirms that participants lie significantly in the non-observed treatments ($p < 0.001$).

Whereas 14 percent report a nine in the Numbers observed treatment (which is not significantly higher than the actual fraction of 11 percent who actually received a nine; $p = 0.106$, binomial test), 22 percent report a nine in the Basic non-observed treatment, which is significantly more than the theoretical prediction ($p < 0.001$). The difference between the Basic and Numbers treatments in reporting a nine is significant ($p = 0.033$, Fisher test). That is, in the non-observed treatment, some of

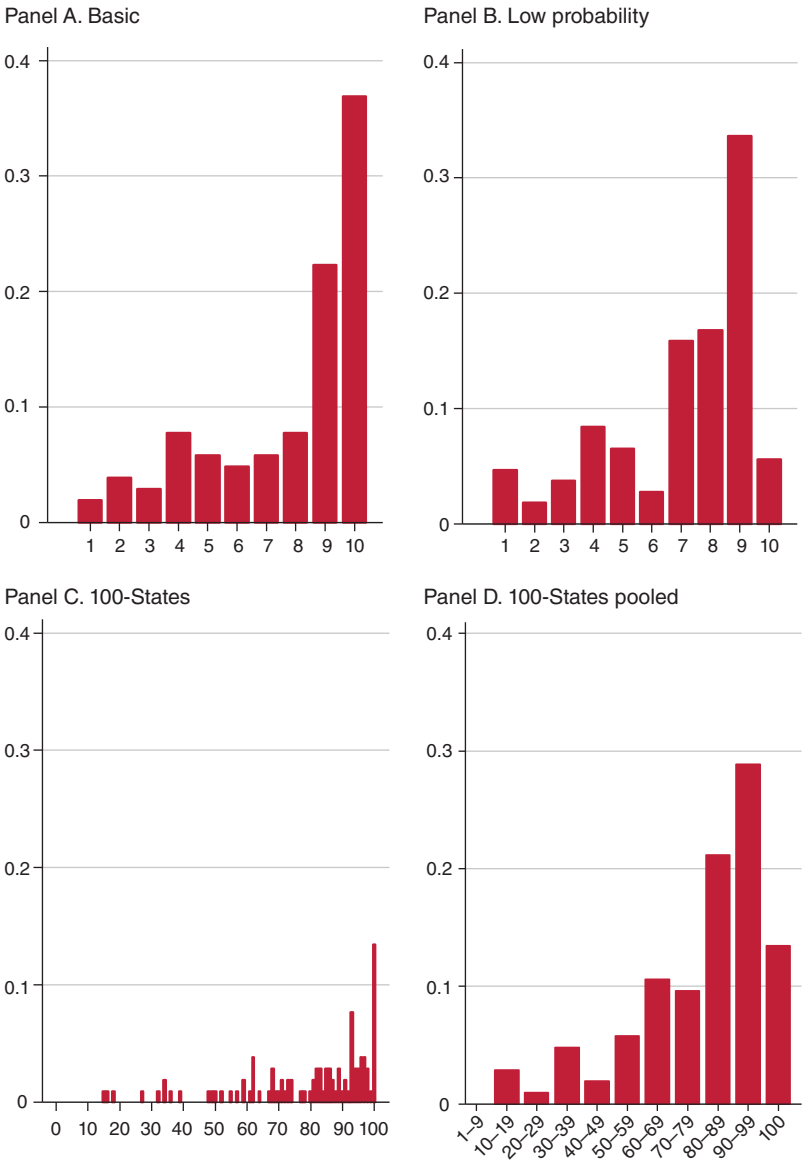

FIGURE 7. DISTRIBUTION OF REPORTED PAYOFFS IN THE NON-OBSERVED TREATMENTS

Note: Figure 7 presents distributions of reported payoffs/numbers in the Basic, Low Probability, and 100-States non-observed treatment.

the participants who lie report a nine instead of the maximal payoff. This result is predicted by Proposition 2 and Hypothesis 4, assuming that some participants care about their social identity. In the non-observed treatment, to signal to the experimenter that she does not lie, a participant who lies may choose to claim high but not maximal numbers, such as eight or nine. Also supporting the social-identity-concern prediction, we find that the overall level of lying is higher in the Basic non-observed treatment than in the Numbers observed treatment (average reported number/payoff of 7.81 versus 7.02, respectively, $p = 0.016$, MWU), indicating some participants

do not lie in the observed treatment because the experimenter may know they did.[25] Hence, we conclude the following.

RESULT 4: *In line with social identity concerns, a larger fraction of participants lies partially in the non-observed treatment than in the observed treatment.*

Previous evidence showing partial lying in variations of the non-observed treatment was interpreted as a desire to maintain a positive self-image. For example, Mazar, Amir, and Ariely (2008, p. 633), conclude that "A little bit of dishonesty gives a taste of profit without spoiling a positive self-view." Although replicating the partial-lying finding, our results do not support this interpretation. Instead, our results suggest that partial lies are primarily due to social identity concerns, because the partial lying that might be caused by self-image concerns is low in the observed games and substantially increases in the non-observed game.

Hypothesis 6 predicts that a lower prior probability of the highest outcome will increase the number of values reported dishonestly. The Low-Probability and 100-States non-observed treatments were designed to test this prediction. Recall that in the Low-Probability treatment, we reduced the probability of a "ten" to 1 percent. Figure 7b presents the results from the Low-Probability treatment.

Consistent with the model's predictions, lowering the prior of the highest outcome increased the range of values reported dishonestly. In the Basic treatment, only the fractions of reports of nine and ten are higher than the prior (22 percent and 37 percent, respectively, compared to 10 percent prior; $p < 0.001$, binomial test). In contrast, in the Low-Probability treatment, participants overreport eight, nine, and ten (marginally) statistically significantly and seven is overreported but not significantly so. Here, 16 percent report a seven (compared to 11 percent prior, $p = 0.120$), 17 percent an eight (compared to 11 percent prior, $p = 0.063$), 34 percent a nine (compared to 11 percent prior, $p < 0.001$), and 6 percent a ten (compared to 1 percent prior, $p < 0.001$).

RESULT 6a: *Consistent with Hypothesis* 6*, when a payoff of* 10 *has a* 1 *percent chance, a larger number of values is reported dishonestly.*

Hypothesis 6 predicts that a lower prior probability of the highest outcome will increase the probability of partial lies. In the Basic non-observed treatment, only nine and ten are overreported relative to the expected fraction. Twenty three (22.33 percent) out of 103 participants reported 9 compared with the expected 10 percent who received 9. Thus, we estimate the partial lying to be 12.33 percent in this treatment. In the Low-Probability non-observed treatment, seven, eight, nine, and ten are overreported. Eleven percent are expected to observe each of the numbers 7, 8, and 9, but 17 (15.89 percent), 18 (16.82 percent), and 36 (33.64 percent) out of 107 participants claimed to do so. Therefore, in the Low-Probability treatment, the

[25] In the observed game, a lie must lead to $\rho = 0$. Therefore, the incentive to tell a partial lie in the observed game is lower (in the non-observed game, someone might tell a partial lie in order to improve her social identity relative to a full lie). Even without variation in ρ, partial lies are possible in the observed game (due to variations in the cost function), but observability makes all lies less important. Social identity does play a role in the observed game because the social identity term adds α to honest reports (and 0 otherwise).

estimated partial lying is 33.36 percent $(71 - 35.31)/107$, with 71 being the sum of participants claiming 7–9, and 35.3, the expected fraction of participants who observed 7–9.

RESULT 6b: *Consistent with Hypothesis* 6*, when a payoff of ten has a* 1 *percent chance, the fraction of partial lies increases relative to when the payoff of ten has a* 10 *percent chance.*

López-Pérez and Spiegelman (2013) conduct an experiment related to this result. In their experiment, a subject sees either the color green or blue and is asked to report a color. The subject receives a higher monetary payoff for reporting green than blue (the monetary payoff depends only on the report, not on the actual color). The subject next guesses the fraction of subjects that report green dishonestly and guesses the average assessment of dishonest reports provided by previous subjects. The authors run two treatments, which vary the prior probability that the true state is green. López-Pérez and Spiegelman (2013) point out that if the cost of lying depends only on the report, then the amount of lying should be the same in both treatments. They show that most subjects either report honestly or always report green. Increasing the prior probability that the true color is blue decreases the probability that subjects report blue independent of the true color, although this finding is not statistically significant. This result is consistent with our Result 6b.[26]

The low-probability treatment demonstrates that making the highest possible outcome relatively less likely than the other outcomes makes participants report a larger range of outcomes dishonestly. In the 100-States treatment we test whether lowering the absolute probability of the highest state has a similar effect. Figure 7, panel C, presents the results and Figure 7, panel D, presents the aggregate results.

To test Hypothesis 7—that increasing the states increases the number of values reported dishonestly—we compare the data from the 100-States treatment with the Basic treatment. As described above, in the Basic treatment, only nine and ten are overreported (two out of ten possible outcomes). In the 100-States treatment, we find that 22 out of 100 outcomes are overreported relative to the expected 1 percent. The cutoff at which numbers are reported dishonestly is lower than in the 10-States condition. Significant overreporting starts at 62 (out of 100) in the 100-States condition. It starts at nine (out of ten) in the 10-States condition. We summarize this finding in Result 7a.

RESULT 7a: *Consistent with Hypothesis* 7*, the range of values reported dishonestly in the* 100*-States treatment is larger than in the* 10*-States treatment.*

Finally, to test Hypothesis 7—that increasing the number of states will increase the probability of partial lies—we compare estimated partial lying in the Basic treatment (12.33 percent) with the 100-States treatment. We estimate partial lying in

[26] López-Pérez and Spiegelman (2013) present a theory that predicts that increasing the prior probability of the low-value observation (blue) will increase the fraction of subjects who report green when they observe blue. This prediction is the opposite of what we find. In their model, agents suffer losses from lying to the extent that lying is perceived as unusual. When the prior probability of green is low, the conditional probability that a report of green is dishonest is high, which lowers the cost of the lie in their model.

100-States treatment by analyzing pooled intervals and identifying which intervals are overreported. We divide the data into 11 groups: 1–9, 10–19, . . . , 90–99, and 100. We find that 60–69, 80–89, and 90–99 are overreported, with 60.58 percent reporting those outcomes. We conclude that partial lying amounts to 30.58 percent $(60.58 - 30)$ in the 100-States treatment.

RESULT 7b: *Consistent with Hypothesis 7, increasing the states increases the fraction of partial lies.*

To obtain Result 7b, we isolate the highest state and pooled lower intervals in groups of ten. Isolating the highest state is consistent with our objective of identifying whether reducing the probability of the highest state leads to a lower fraction of agents making the highest claim. If we pool together states 1–10, 11–20, . . . , 91–100, then there is statistically significant overreporting only in the two highest pools, which is consistent with Proposition 7 and, in particular, the ideas that increasing the number of states does not qualitatively change lying behavior.

VI. Conclusion

In this paper, we formalize an important aspect of the intrinsic costs of lying—how the size of the lie affects the decision to lie. We discuss three possible kinds of lying costs: a cost related to the distance between the true outcome and what is reported; a cost related to the monetary gains generated by the lie; and a cost associated with the probability that a statement is perceived to be dishonest. Although the literature has discussed the first two dimensions, it has neglected the third dimension.

The model we construct allows us to consider the influence of the size of the lie on lying decisions and to generate novel predictions that we test experimentally. In line with the properties of the equilibrium of our model, we find evidence for a cutoff value: if the payoff associated with the observed outcome is high enough, then people do not lie, and lies occur only when the payoff is below this cutoff. In equilibrium, subjects who make higher claims are perceived as being less honest. In the experiment, as the model predicts, dishonest claims of the maximal value always occur. When lying does not lead to the lowest possible social identity (by making the outcome non-observed), there is more lying and, in particular, more partial lying. Another finding that supports the social identity argument is that when making the maximal outcome less likely ex ante, the frequency of partial lies increases.

We conclude that social identity has an important impact on lying costs. Our findings indicate that the other two dimensions (the outcome and the payoff dimensions) have smaller effects on lying behavior. For example, we find that the outcome dimension has no effect on the number of people who choose to lie and a small effect on partial lying.

Our paper offers a formal treatment and systematic experimental analyses of the intrinsic cost of lying and its interaction with the size of the lie. Several interesting experiments follow from our discussion. We hope they will be the subject of future research. A natural extension is to test what happens when we introduce a Numbers Mixed and a Words treatment, designed to separate the reported outcome dimension from the payoff dimension, into the non-observed game. A more challenging

problem is to estimate the effect of the payoff costs on the extensive margin. Another interesting question is what happens when there is an exchange rate between the benefit to the decision maker and the cost to another player. Although we have tried to understand the importance of the interplay between social identity and regular interpretation of reputation, open questions remain. For example, participants may believe their reports influence the chance they will be invited back to the laboratory, causing them to view the interaction as more than a one-shot game. Future research can use a double-blind procedure in which the experimenter does not know the decision made by individual participants.

Appendix

Table A1—The Relation Between Number Reported and Payoff in the Numbers Mixed Treatment

Number	7	3	1	8	4	9	5	10	6	2
Pay in €	1	2	3	4	5	6	7	8	9	10

Table A2—The Relation Between Word Reported and Payoff in the Words Treatment

Word	vilkas	miskas	dangus	stirna	rojuje	siaure	kiskis	alyvos	obelis	pietus
Pay in €	1	2	3	4	5	6	7	8	9	10

Note: The meaning of the words is: wolf, forest, heaven, deer, paradise, north, rabbit, lilac, apple, south.

Table A3—The Fraction of People Who Lie After Observing a Payoff and the Fraction Who Lie by Reporting that Payoff, for Each Treatment

	Fraction who lied after observing this payoff				Fraction who lied by reporting this payoff			
Payoff	Numbers	Words	Numbers mixed	Pooled	Numbers	Words	Numbers mixed	Pooled
1	47.37	27.27	28.57	41.07	0	0	0	0
2	42.86	71.43	—	46.94	0	0	0	0
3	28.13	50	45.45	35.85	0	0	0	0
4	39.29	20	30.43	32.79	0	0	3.33	0.60
5	32	44.44	22.22	32.35	0.97	0	3.33	1.20
6	29.41	37.5	18.18	28.30	3.88	0	3.33	2.99
7	26.01	28.57	31.25	27.63	4.85	2.94	0	3.59
8	22.58	71.43	27.27	30.61	10.68	5.88	0	7.78
9	4.65	25	14.29	9.68	11.65	0	10	8.98
10	0	0	7.69	1.37	67.96	91.18	80	74.85

Notes: The results presented in the table are measured in payoffs. On the left side of the table, we report what fraction of participants lie after observing a particular payoff (from observing a payoff of 1 to 10 down the table) and on the right side of the table, we report the fraction of participants who lie by reporting a particular payoff (from reporting a payoff of 1 to 10 down the table).

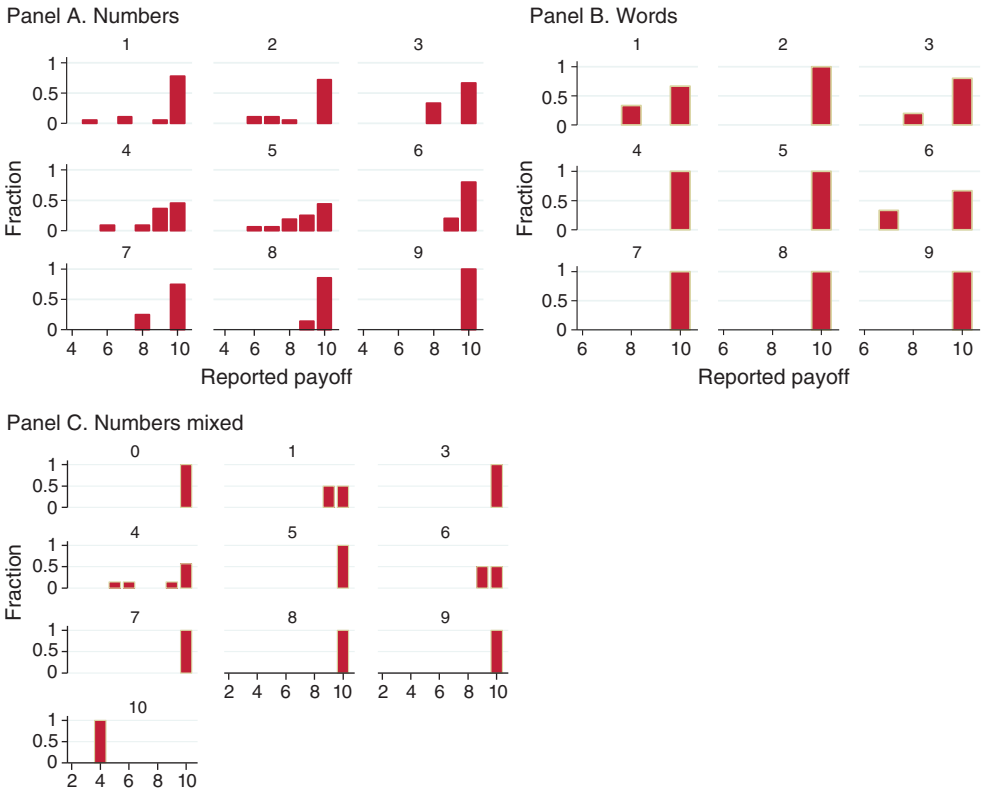

FIGURE A1. DISTRIBUTION OF PAYOFFS REPORTED BY PARTICIPANTS WHO LIE, FOR EACH ACTUAL PAYOFF

Notes: Figure 5, panels A through C, represent the distribution of reported payoff conditional on lying for each actual payoff separately. The number on the top of the cell stands for the actual payoff, and the numbers on the *x*-axis, for the reported payoffs. The number of observations amounts to 103, 34, and 30 in panels A, B, and C, respectively.

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