



**HAL**  
open science

## Utilizing simple cues to informational dependency

Hugo Mercier, Helena Miton

► **To cite this version:**

Hugo Mercier, Helena Miton. Utilizing simple cues to informational dependency. *Evolution and Human Behavior*, 2019, 40 (3), pp.301-314. 10.1016/j.evolhumbehav.2019.01.001 . ijn\_03081055

**HAL Id: ijn\_03081055**

**[https://hal.science/ijn\\_03081055](https://hal.science/ijn_03081055)**

Submitted on 22 Oct 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

## UTILIZING SIMPLE CUES TO INFORMATIONAL DEPENDENCY

Mercier, H.

CNRS

Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, PSL University, CNRS, Paris

France

[hugo.mercier@gmail.com](mailto:hugo.mercier@gmail.com)

Miton, H.

Department of Cognitive Science, Central European University

7, Oktober-6 utca, 1061 Budapest, Hungary

[helena.miton@gmail.com](mailto:helena.miton@gmail.com)

CUES TO INFORMATIONAL DEPENDENCY

UTILIZING SIMPLE CUES TO INFORMATIONAL DEPENDENCY

**Abstract**

Studies have shown that participants can adequately take into account several cues regarding the weight they should grant majority opinions, such as the absolute and relative size of the majority. However, participants do not seem to consistently take into account cues about whether the members of the majority have formed their opinions independently of each other. Using an evolutionary framework, we suggest that these conflicting results can be explained by distinguishing evolutionarily valid cues (i.e. they were present and reliable during human evolution) from other cues. We use this framework to derive and test five hypotheses (H1 to H5). Our first three experiments reveal that participants discount majority opinion when the members of the majority owe their opinions to the same hearsay (H1), owe their opinions to having perceived the same event (H2), or owe their opinions to a common motivation (H3). Experiment 4 suggests that, by contrast, participants do not discount majority opinion when the members of the majority owe their opinions to sharing similar cognitive traits (H4). Finally, Experiment 5 suggests that participants adequately discount majority opinion when one of the members of the majority is untrustworthy (H5). This set of experiments shows that participants can be quite skilled at dealing with informational dependency, and that an evolutionary framework helps make sense of their strengths and weaknesses in this domain.

*Keywords:* Majority rule; Informational conformity; Informational dependency; Trustworthiness.

### Utilizing simple cues to informational dependency

How many people hold an opinion, or engage in a given behavior, can be a very good cue regarding the validity of the opinion, or the efficiency of the behavior. Condorcet offered the first mathematical demonstration of the power of majority rules in the late eighteenth century (Condorcet, 1785). Since then, further mathematical proofs (Ladha, 1992), simulations (Hastie & Kameda, 2005), and experiments (Hastie & Kameda, 2005) have comforted the conclusion that following the majority is often a sound heuristic (as is following the plurality when there are more than two options, see Hastie & Kameda, 2005).

The present article explores how well humans take into consideration one crucial parameter when deciding how much to follow majority opinions: whether the members of the majority have reached their opinions independently of each other. We start by briefly reviewing the literature on whether people follow majority rules adequately, suggesting that an evolutionary framework can account for apparently discordant results. We then look in more detail at one crucial parameter regarding the validity of majority rules: whether the members of the majority formed their opinions independently of each other—i.e. whether the majority suffers from informational dependencies. Based on the same evolutionary framework, we draw a series of hypotheses regarding which cues to informational dependencies people should be better able to take into account. Finally, we test these hypotheses in a series of experiments.

#### *Majority rules and informational conformity*

## CUES TO INFORMATIONAL DEPENDENCY

Given their usefulness, it is unsurprising that majority rules can be found throughout the animal kingdom (e.g. Conradt & List, 2009; Conradt & Roper, 2003). One of the best examples was provided by a study of baboons (Strandburg-Peshkin, Farine, Couzin, & Crofoot, 2015). GPS tracking enabled the researchers to look at the decisions made by each baboon when the troop was starting to split into two subgroups. The baboons were more likely to follow the largest of the two subgroups, and this tendency grew stronger with the difference in size between the two subgroups.

Humans, compared to other primates, live in larger groups, and rely more on cooperation (Sterelny, 2003; Tomasello, 2010). Moreover, humans rely vastly more on communication than any other primate species. As a result, we should expect humans to be able to take majority rules into account not only in weighing what other people do (e.g. Henrich & Boyd, 1998; Richerson & Boyd, 2005), but also when weighing what they say.

Studies of majority rule in humans, however, have yielded conflicting results. Some experiments suggest that people have no understanding of the benefits of majority rules. When presented with the majority opinion on policy issues, people are as likely to move their opinions towards the majority opinion as away from it (for review, see Mutz, 1998). When asked to imagine whether an assembly voting with a majority rule would be more likely to select the correct option than any of its individual members, people have no intuition that the former is more likely to be right than the latter, even when mathematics dictates that this should be the case (Mercier, Dockendorff, & Schwartzberg, submitted).

By contrast, other experiments find that people not only follow majority rules, but do so broadly rationally. For example, Morgan and his colleagues (2012) gave

## CUES TO INFORMATIONAL DEPENDENCY

participants a series of tasks (such as mental rotations), providing the participants with what they thought to be the individual answers of other participants. Participants were more likely to follow the majority when it was larger in absolute terms, larger in relative terms (i.e. closer to a consensus), and when they were less sure of themselves. These findings are in line with a long tradition of conformity studies in social psychology (for reviews, see Bond, 2005; Mercier & Morin, submitted). When concerns about normative conformity are removed, participants follow majority rules in a broadly rational fashion (i.e. in a way that optimizes information gains).

It has been suggested that an evolutionary framework can help understand why people ignore majority rules altogether in some cases, and follow them well in others (Mercier & Morin, submitted). Just as the human reliance on cooperation made of dealing with cheaters a significant evolutionary problem (Cosmides, 1989), the human reliance on communication made of dealing with unreliable senders and messages a significant evolutionary problem (on the evolution of communication more generally, see Maynard Smith & Harper, 2003). Had people been unable to properly evaluate what they were told—accepting most reliable messages, rejecting most unreliable ones—communication could not have remained evolutionarily stable. Accordingly, humans should have been endowed with mechanisms whose function is to evaluate communicated information, which have been dubbed mechanisms of epistemic vigilance (Sperber et al., 2010).

A wealth of experiments shows that humans are able to take a wide variety of cues into account in order to evaluate communicated information, from how well messages fit with their prior beliefs, to how competent and honest the source is deemed to be (Bonaccio & Dalal, 2006; Harris, 2012; Mercier, submitted, 2017). Moreover, many of these skills are very early developing, some being present at 2

years of age (Castelain, Bernard, & Mercier, 2018; Harris & Lane, 2014), many others developing through the preschool years (for review, see Harris, 2012).

The importance of communication and of majority rules suggests that some mechanisms of epistemic vigilance should be dedicated to the use of majority rules in the case of communicated information. These mechanisms should make us more likely to accept an opinion when we see that many people, who we deem competent and honest, all hold this opinion. As mentioned above, this is what experiments on conformity reveal. However, these mechanisms should not give us access to an abstract understanding of the power of majority rules—in the same way that naïve physics does not help us understand theoretical physics. This is why people do not take majority rules into account when the information is presented in an explicit, abstract manner.

We can thus distinguish between evolutionarily valid cues—cues that were present and reliable in the EEA—and non-evolutionarily valid cues—such as cues that are recent cultural innovations (Mercier & Morin, submitted). Being told by many individuals that they hold the same opinion is an evolutionarily valid cue, while a percentage representing the same distribution of opinions is a non-evolutionarily valid cue (for a direct comparison, see Mercier, Majima, Claidière, & Léone, submitted). The distinction between evolutionarily valid cues and non-evolutionarily valid cues helps make sense of the apparently contradictory results regarding how people deal with majority rules. On the whole, it seems that participants react broadly appropriately when the cues are evolutionarily valid—e.g. seeing the individual answers of a number of participants—and fail to do so when the cues are not-evolutionarily valid—e.g. being provided with a numerical description of a voting scenario.



## CUES TO INFORMATIONAL DEPENDENCY

In some ways, the difference between evolutionarily valid and non-evolutionarily valid cues is similar to the difference between decisions from experience and decisions from descriptions. Experiments on risky choice have manipulated whether participants are exposed to descriptions—for example, explicitly providing the probabilities of the different outcomes of a gamble—or to experiences—for instance, providing participants with a series of gambles in which they slowly learn the probability of each outcome (for review, see Hertwig & Erev, 2009). Participants react very differently to these two situations. Arguably, this is because one cue—the repeated series of gambles—is more evolutionarily valid than the other—the explicit description of probabilities.

### *Informational dependencies*

A crucial component of majority rules that we have not mentioned so far is independence. For the majority opinion to be reliable, members of the majority must have acquired their opinions largely independently of each other. If all your friends recommend you go see a given movie because they have all seen the movie and liked it, it is probably good advice. But if only one of them has seen it, and the others all rely on this friend's opinion, then the consensus is much less indicative (although see Estlund, 1994).

Several experiments have examined whether participants take cues to informational dependencies into account (e.g. Hess & Hagen, 2006; Maines, 1990; Whalen, Griffiths, & Buchsbaum, 2018; for review, see Mercier & Morin, submitted). Most of them have yielded negative results. For example, one experiment found that participants did not appropriately discount the convergent opinions of several

## CUES TO INFORMATIONAL DEPENDENCY

forecasters after being told that “the correlation among forecast errors was approximately +.8 for all forecaster pairs” (Maines, 1990, p. 36).<sup>1</sup>

By contrast, a few experiments have shown that in some cases people can take informational dependencies into account. For instance, in an experiment designed for preschoolers but also conducted with adults, participants were provided with the contradictory opinions of two groups of informants (Hu, Whalen, Buchsbaum, Griffiths, & Xu, 2015). Informants from the first group all had perceptual access to the relevant information and thus formed their opinions independently of each other. Informants from the second group formed their opinion mostly through hearsay: one informant had perceptual access to the relevant information, and communicated her opinion to the second informant, who communicated it to the third, etc. In this case, adult participants were more likely to follow the opinion of the first group even if it comprised only four members while the second comprised six members (see also Whalen, Buchsbaum, Griffiths, & others, 2013).<sup>2</sup> This means that the adults discounted the opinion of the larger group, because all but one of these opinions depended on someone else’s opinion, rather than on independent perceptual access.

### *Evolutionary validity of cues to informational dependencies*

---

<sup>1</sup> Even though the participants were “M.B.A. students in a financial statement analysis course at the University of Chicago [who] had been exposed previously to the concept of statistical correlation and its effect on the variance of a sum of random variables in prerequisite courses in statistics and finance.” (Maine, 1990, p.36).

<sup>2</sup> Preschoolers, by contrast, only favored perceptual access over hearsay when both groups were of the same size.

We suggest that, as for majority rules generally, this pattern of successes and failures can be explained within a framework that distinguishes evolutionarily valid from non-evolutionarily valid cues to informational dependencies.<sup>3</sup>

Experiments in which participants do not take informational dependencies into account use cues that are recent cultural inventions, such as correlation coefficients (e.g. Maines, 1990). These cues would not be evolutionarily valid, thus explaining the participants' failure to take them into account.

By contrast, the cues present in the experiment by Hu *et al.* (2015) would be evolutionarily valid. If contemporary human societies, including small-scale ones, are any guide to the past, we can infer that throughout our recent evolution people would generally have had information about the sources of people's opinion. This information could have been gathered directly, as in the experiment by Hu *et al.* (2015), or it could have been provided by the speakers (e.g. Aikhenvald, 2004, p. 10ff). In some languages, providing information about the sources of one's opinions is made grammatically mandatory by evidentials. Even if evidentials do not make it mandatory to specify the exact source of one's opinion they give the audience some relevant information. For example, speakers of Wanka Quechua must add a marker to their assertions specifying whether the information was acquired via direct perception, inference (i.e. one's personal thought process), or hearsay (Aikhenvald, 2004, p. 43). In languages that do not have evidentials, information about the sources of one's opinions can be conveyed through a variety of means, for instance by making the source explicit ("Peter told me") (see, e.g. Aikhenvald, 2004, p. 10ff).

---

<sup>3</sup> An exception might be the recent experiments by Yousif *et al.* (2018). A potential interpretation of their findings is that people interpreted the context in which the different sources were presented (i.e. newspapers having called on either different experts or the same expert) as providing independent evidence of the competence of the sources, such that an expert called on by multiple newspapers would have been perceived as more competent (see Estlund, 1994).

## CUES TO INFORMATIONAL DEPENDENCY

The literature on evidentials suggests that the most common of these markers specify whether the opinion stems from inference, hearsay, or first-person perception (as in the example above, see Aikhenvald, 2004). Arguably, even in languages that do not have evidentials, these three categories tend to dominate the type of information about sources provided by informants (see, e.g. Aikhenvald, 2004, p. 10ff). This suggests that the two most obvious external sources of information that can yield informational dependencies are hearsay and perception. As a result, this type of information should be an evolutionarily valid cue, leading to our first two hypotheses:

H1: People take informational dependencies into account when they know several individuals owe their beliefs to the same source through hearsay (i.e. they have all heard the information from the same individual).

H2: People take informational dependencies into account when they know several individuals owe their beliefs to perceiving the same event (e.g. they have all seen the same event).

Another cue that would have likely been present throughout our evolutionary history is the potential for motivational bias. One of the main dangers that our mechanisms of epistemic vigilance protect receivers against stems from the different incentives of senders and receivers. People do take incentives into account when evaluating communicated information, for instance by discounting self-serving messages (Snizek, Schrah, & Dalal, 2004; for work on children, see Mills & Keil, 2005; Reyes-Jaquez & Echols, 2015). These incentives can also give rise to

## CUES TO INFORMATIONAL DEPENDENCY

informational dependencies. If you expect several people of having the same incentives (say, being liked by the same person), and you expect these incentives to bias their opinions (to be more likely to claim this person is kind or competent), then you should expect all the opinions to be biased in the same way (they would all claim this person is great), providing a reason to discount the convergence between the opinions. A wealth of work in evolutionary psychology has shown the importance of coalitional thinking, and of recognizing when the incentives of various groups are aligned or not (e.g. Tooby, Cosmides, & Price, 2006). This leads to our third hypothesis:

H3: People take informational dependencies into account when they stem from common motivational biases (motivational dependencies).

Along with motivational biases, there have been discussions in the recent literature of how common cognitive factors can yield informational dependencies. For example, Page and colleagues (Hong & Page, 2004; Page, 2007) have argued that people with a diverse set of cognitive tools form more efficient teams. Without being motivationally biased, people who possess the same cognitive tools (same heuristics, same knowledge, etc.) are likely to agree on, say, what the best solution to a problem might be. As a result, it is good to be mindful of cognitive diversity, and to grant it appropriate weight. However, in the environment in which we evolved, cognitive diversity was vastly reduced compared to the modern world. The range of expertise was infinitely smaller than it is now. The immense range and diversity of expertise present in our modern environment might help explain why people find it so difficult to recognize the competence of those who have vastly superior expertise (Kruger &

## CUES TO INFORMATIONAL DEPENDENCY

Dunning, 1999). Similarly, people might not be able to take the cognitive diversity of informants into account when assessing communicated information. In an experiment participants had been asked to rate the strength of an argument purely based on the reaction of an audience to the argument (Mercier & Strickland, 2012). Although participants reacted appropriately to several factors (such as audience size), they did not take audience diversity into account. This suggests that the participants did not consider the potential for cognitive dependencies between the audience members to lower the value of their opinion. These considerations lead to hypothesis 4:

H4: People do not take informational dependencies into account when they stem from similarities in the cognitive makeup of individuals (cognitive dependencies).

Experiments on informational conformity tend to assume that informants reveal their true opinions. However, this is obviously not always the case. An informant could doubt the trustworthiness of all the informants who agree on a given opinion, in which case this opinion should obviously be discounted. More interesting is the case in which the trustworthiness of only a minority of the informants is in doubt. Two reactions are then possible. The fact that the majority, composed of trustworthy informants, agrees with a minority composed of less trustworthy informants might suggest that the less trustworthy informants can in fact be trusted, and thus that their opinions should be counted as if they were trustworthy. We should then expect little or no difference between the weight granted the opinion of a group of trustworthy informants, and that of a group of informants containing a majority of trustworthy informants as well as a few untrustworthy informants. Alternatively, doubts regarding

## CUES TO INFORMATIONAL DEPENDENCY

the trustworthiness of some informants might affect how much weight is granted to an opinion, even if the opinion is also supported by a majority of trustworthy informants.

The latter option is arguably more rational, because the opinions of the less trustworthy informants are not truly independent. If the opinions of trustworthy informants are used to assess the trustworthiness of other informants, then the opinions of the latter informants become partly dependent on that of the former. As a result, even if the opinion of the trustworthy informants can lead to a change of mind regarding the trustworthiness of other informants, then the opinion of these informants should still be discounted to some extent.

One of the functions of epistemic vigilance is to ward off messages from untrustworthy sources. Moreover, given the costs of deception, epistemic vigilance mechanisms should tend to err on the side of caution, leading us to reject more potentially reliable messages than we accept potentially unreliable ones. This leads us to our fifth and final hypothesis:

H5: People discount majority opinions when a few members of the majority are suspected of not being trustworthy, compared to a situation in which no such suspicion arises.

Each hypothesis is tested in one experiment, with each experiment having two sets of materials. Each experiment is then subject to an exact replication.

### **Experiment 1**

The goal of this experiment is to test the following hypothesis:

## CUES TO INFORMATIONAL DEPENDENCY

H1: People take informational dependencies into account when they know several individuals owe their beliefs to the same source through hearsay (i.e. they have all heard the information from the same individual).

Three different variables are manipulated in Experiment 1: number of informants, dependency between the opinion of the informants, and framing. Participants are provided with the opinions of either one (One informant condition) or three (Three informants condition) informants regarding a fictitious restaurant. The participants then have to rate the restaurant, with the information provided by the informants as only basis. The degree of dependency between the informants' opinions is manipulated: in the No Dependency condition, the opinions appear independent, whereas in the Dependency condition, they are clearly dependent on a common third party through hearsay. We also manipulate whether the opinions were positive or negative, as a robustness check (Positive / Negative framing conditions).

### *Methods*

#### Participants

398<sup>4</sup> participants were recruited through Amazon Mechanical Turk (191 females,  $M_{age} = 34.94$ ,  $SD = 12.23$ ). Participants were paid \$0.2 for their participation. This sample size was selected because power analyses suggested it would provide us with sufficient power to detect effects of moderate size (such as those obtained in the most closely related past experiments, Hu et al., 2015).

#### Design

After completing a consent form, participants read a short vignette and answered one question related to the vignette, before providing some simple

---

<sup>4</sup> A round number of participants were requested in each experiment (e.g. 400 here), but a small share failed to complete the survey.



## CUES TO INFORMATIONAL DEPENDENCY

demographic information. All variables were manipulated between-participants: each participant read a single vignette.

### Materials

The vignettes from the negative framing can be found in Table 1, the equivalent positive framing in the ESM. Participants were asked: “How good do you think the restaurant your friend[s] was [were] talking about is?” They had to provide a numerical answer from 0 to 100.

	No dependency	Dependency (hearsay)
1 Informant	You meet your friend Julia, and you ask her about a new restaurant that opened in your neighborhood.  She tells you: “I don’t think it’s great.”	You meet your friend Julia, and you ask her about a new restaurant that opened in your neighborhood.  She tells you: “I don’t think it’s great. Peter told me it was disappointing.”
3 Informants	You meet your friends Julia, Rob, and Olivia, and you ask them about a new restaurant that opened in your neighborhood. They tell you:  Julia: “I don’t think it’s great.”  Rob: “I don’t think it’s great either.”  Olivia: “I agree it isn’t great.”	You meet your friends Julia, Rob, and Olivia, and you ask them about a new restaurant that opened in your neighborhood. They tell you:  Julia: “I don’t think it’s great. Peter told me it was disappointing.”  Rob: “I don’t think it’s great either. Peter also told me it wasn’t so good.”  Olivia: “I agree it isn’t great. Peter told me it was barely alright.”

Table 1. Vignettes from the negative framing conditions of Experiment 1.

Results and discussion

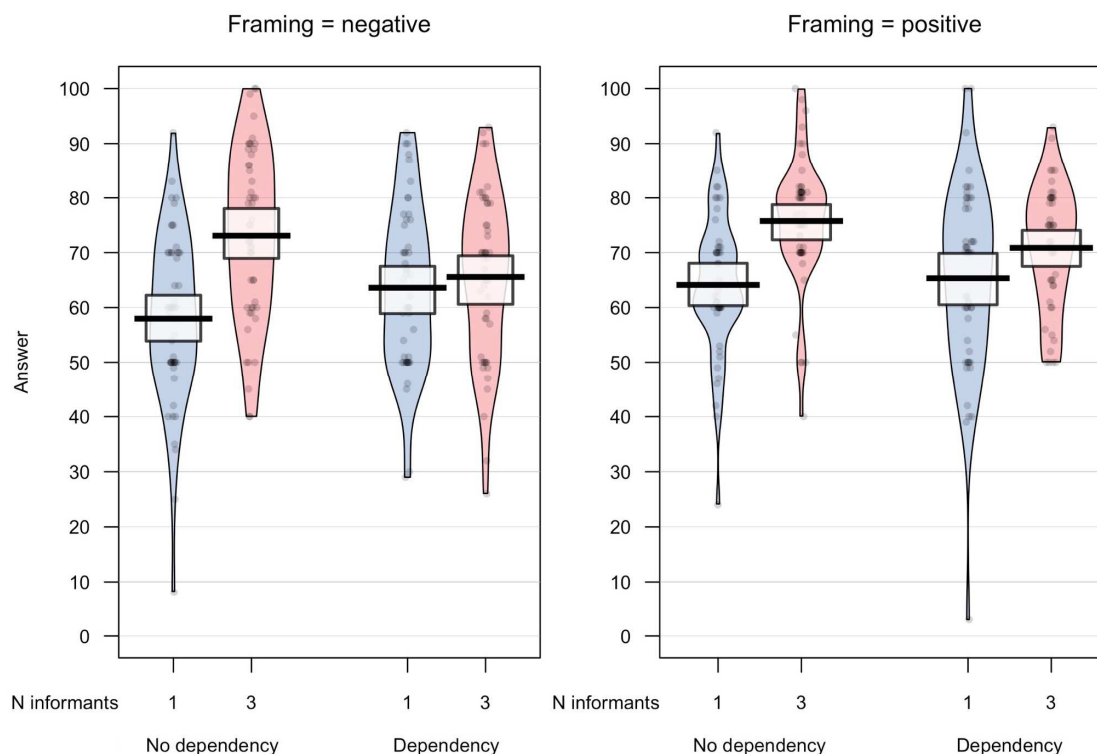


Figure 1. Ratings provided by participants in Experiment 1, in which the dependency was due to hearsay. The scale ranged from 0 to 100, however, to make it easier to compare the positive and negative framings, ratings from the negative framing condition were inverted (e.g. 40 becomes 60), so that higher numbers reflect more negative ratings. Each point is a data point, the horizontal bars represent averages, the boxes Bayesian highest density intervals, and the beans smoothed densities of answers.

Figure 1 provides the results of Experiment 1. H1 predicts that participants, in rating the restaurant, should take the number of informants into account more when their opinions are independent of each other: the difference in the ratings between the One informant and the Three informants conditions should be larger in the No Dependency condition than in the Dependency condition. This means that we should

## CUES TO INFORMATIONAL DEPENDENCY

observe an interaction between the number of informants (One, Three) and the degree of dependency (Dependency, No Dependency).

A Three-Way analysis of variance (ANOVA)<sup>5</sup> was conducted on the influence of three independent variables (Dependency, Number of Informants, Framing) on the ratings the participants gave to the restaurant. This 2 (Dependency) x 2 (Number of Informants) x 2 (Framing) analysis yielded: no significant main effect of Dependency  $F(1, 390) = 0.91, p > .05, \eta_p^2 = .002$ , No Dependency ( $M = 67.74, SE = 1.021$ ), Dependency ( $M = 66.35, SE = 1.037$ ); a significant main effect of Number of Informants,  $F(1, 390) = 34.62, p < .001, \eta_p^2 = .082$ , One Informant ( $M = 62.76, SE = 1.029$ ), Three Informants ( $M = 71.32, SE = 1.029$ ); a significant main effect of Framing,  $F(1, 390) = 7.43, p = .007, \eta_p^2 = .019$ , Positive ( $M = 69.02, SE = 1.032$ ), Negative ( $M = 65.06, SE = 1.026$ ).<sup>6</sup> The critical interaction between Dependency and Number of informants was significant,  $F(1, 390) = 10.91, p = .001, \eta_p^2 = .027$ .

A difference between One and Three informants was expected in the No dependency condition which explains the overall effect of One vs. Three informants. The difference in framing means that the positive messages ("I think it's good) were more persuasive than the negative messages ("I don't think it's great"). Since we had not attempted to precisely calibrate the positive and negative framing, observing such a difference is unsurprising. Since neither of these two main effects have a direct bearing on our hypotheses, they will not be discussed in the following experiments.

The critical interaction revealed that, as predicted by H1, participants were able to take informational dependencies due to hearsay into account: they put less weight on the opinion of three informants, relative to the opinion of one informant,

---

<sup>5</sup> All ANOVAs are Type III Sum of Squares conducted using JASP (version 0.9.0.1).

<sup>6</sup> Reminder: the scores in the negative framing conditions were inverted before analysis, since otherwise the difference between the two conditions would be trivial. As a result, a significant difference in framing means that the scores in one condition are more extreme than in the other.

## CUES TO INFORMATIONAL DEPENDENCY

when the opinion of the three informants all relied on the same third party, than when they appeared independent.

### Replication of Experiment 1

This is an exact replication of Experiment 1, with the same design and materials.

#### Participants

394 participants were recruited through Amazon Mechanical Turk (213 females,  $M_{age} = 36.81$ ,  $SD = 11.74$ ). Participants were paid \$0.2 for their participation.

#### *Results and discussion*

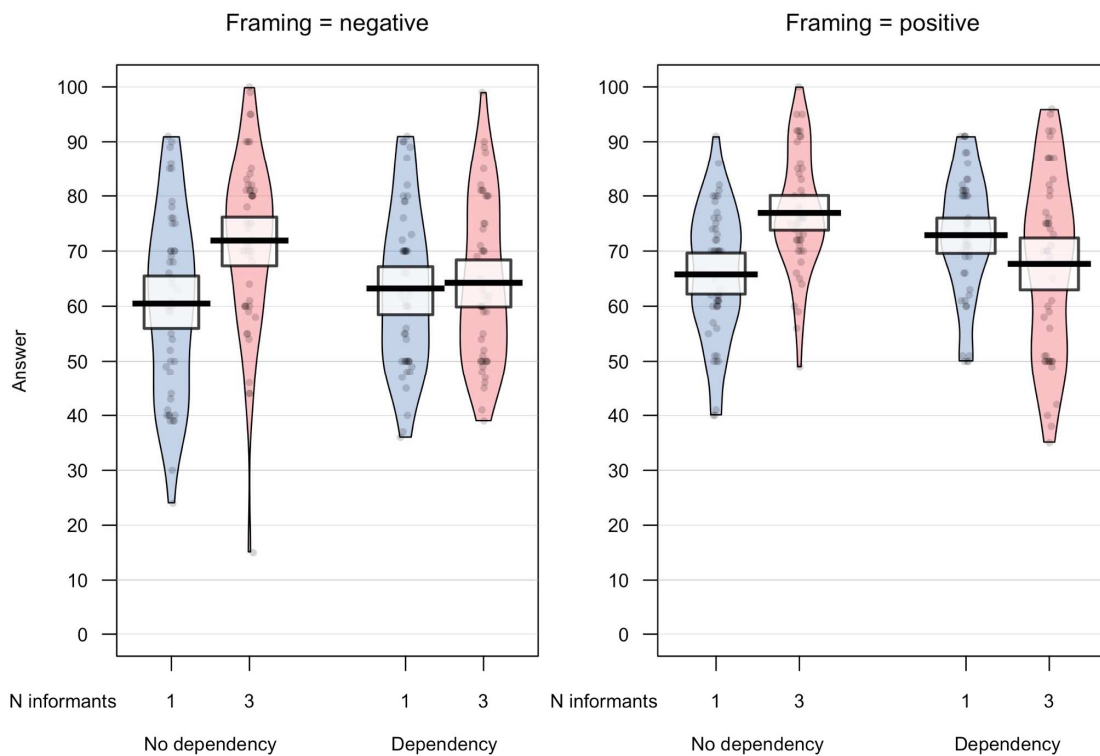


Figure 2. Ratings provided by participants in the replication of Experiment 1 (see Figure 1 for explanations).

Figure 2 displays the results of the replication of Experiment 1. Detailed analyses can be found in the ESM. Crucially, the interaction between Dependency

## CUES TO INFORMATIONAL DEPENDENCY

and Number of informants was significant,  $F(1, 386) = 21.69, p < .001, \eta_p^2 = .053$ .

These results support H1.

### **Experiment 2**

The goal of this experiment is to test the following hypothesis:

H2: People take informational dependencies into account when they know several individuals owe their beliefs to perceiving the same event (e.g. they have all seen the same event).

Experiment 2 manipulates the same three variables as in Experiment 1: number of informants, dependency between the opinion of the informants, and framing. Participants are provided with the opinions of either one (One informant condition) or three informants (Three informants condition) regarding a fictitious colleague (we changed from the restaurant setting of Experiment 1 so that we could use direct visual perception instead of taste). The participants are then asked to rate the colleague, with the information provided by the informants as their only basis. The degree of dependency between the informants' opinions is manipulated: in the No Dependency condition, the opinions appear independent, while the opinions are clearly dependent on having perceived the same event in the Dependency condition. As in Experiment 1, we also manipulate whether the opinions are positive or negative (Positive / Negative framing conditions).

#### *Methods*

##### Participants

## CUES TO INFORMATIONAL DEPENDENCY

399 participants were recruited through Amazon Mechanical Turk (176 females,  $M_{age} = 35.41$ ,  $SD = 11.40$ ). Participants were paid \$0.2 for their participation.

### Design

After completing a consent form, participants read a short vignette and answered one question related to it, before providing some simple demographic information. All variables were manipulated between-participants: each participant only read a single vignette.

### Materials

The vignettes from the negative framing can be found in Table 2, the equivalent positive framing in the ESM. All stories had the same introduction:

You are the manager in a clothing store, and you are talking with the other three employees about Michael, who is finishing up his trial period. The three employees—Paul, Rick, and Bob—are reporting their impressions of Michael, and telling of various things they've seen him do, some of which are positive, some negative.

Participants were asked: "How competent to you think Michael is?" They had to provide a numerical answer from 0 to 100.

	No dependency	Dependency (perception of the same event)
1 Informant	During the discussion, Paul says: "I don't think he's very competent."	During the discussion, Paul says: "This morning, I saw him put two antitheft devices on the same dress."

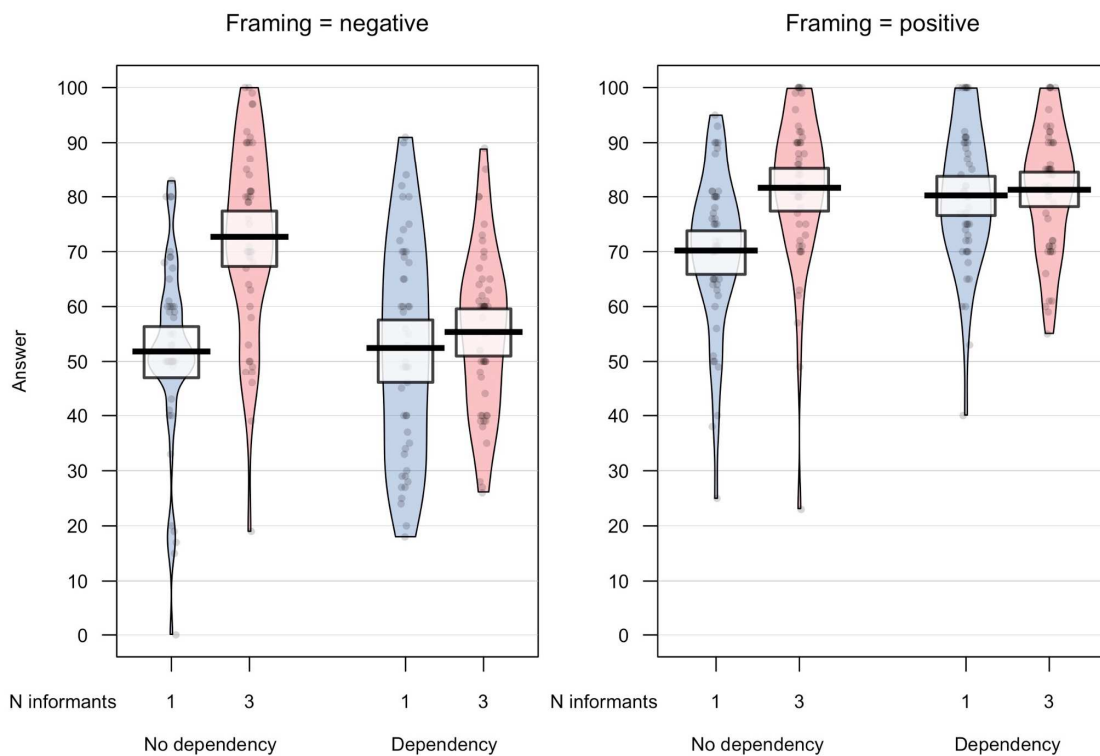
## CUES TO INFORMATIONAL DEPENDENCY

3 Informants	During the discussion, Paul says: "I don't think he's very competent." Rick says: "I don't think he's very competent either." And Bob says: "I agree."	During the discussion, Paul says: "This morning, I saw him put two antitheft devices on the same dress." Rick says: "I saw that too this morning." And Bob says: "Yes, me too."
--------------	--	---

Table 2. Vignettes from the negative framing conditions of Experiment 2.

Compared to the vignettes from Experiment 1, we chose to leave the negative judgments implicit in the Dependency condition, as, in this higher-stakes context, participants might have inferred that the judgments did not rest only on perceiving this one event, thereby reducing the informational dependency.

### Results and discussion



## CUES TO INFORMATIONAL DEPENDENCY

*Figure 3.* Ratings provided by participants in Experiment 2, in which the dependency was due to having perceived the same event (see Figure 1 for explanations).

Figure 3 provides the results of Experiment 2. As H1, H2 predicts that participants, in rating the colleague, should take the number of informants into account more when their opinions are independent of each other, so that we should observe an interaction between the number of informants (One, Three) and the degree of dependency (Dependency, No Dependency).

A Three-Way analysis of variance (ANOVA) was conducted on the influence of three independent variables (Dependency, Number of Informants, Framing) on the ratings the participants gave to the colleague. This 2 (Dependency) x 2 (Number of Informants) x 2 (Framing) analysis yielded: no significant main effect of Dependency  $F(1, 391) = 1.28, p = .26, \eta_p^2 = .003$ , No Dependency ( $M = 69.09, SE = 1.094$ ), Dependency ( $M = 67.33, SE = 1.097$ ); a significant main effect of Number of Informants,  $F(1, 391) = 34.26, p < .001, \eta_p^2 = .081$ , One Informant ( $M = 63.68, SE = 1.097$ ), Three Informants ( $M = 72.74, SE = 1.094$ ); a significant main effect of Framing,  $F(1, 391) = 170.87, p < .001, \eta_p^2 = .304$ , Positive ( $M = 78.34, SE = 1.088$ ), Negative ( $M = 58.09, SE = 1.102$ ). The critical interaction between Dependency and Number of informants was significant,  $F(1, 391) = 20.91, p < .001, \eta_p^2 = .051$ .

As predicted by H2, participants were able to take informational dependencies due to perception of the same event into account: they put less weight on the opinion of three informants, relative to the opinion of one informant, when the opinion of the three informants all relied on the same event.

### **Replication of Experiment 2**

This is an exact replication of Experiment 2, with the same design and materials.

#### Participants



## CUES TO INFORMATIONAL DEPENDENCY

400 participants were recruited through Amazon Mechanical Turk (188 females,  $M_{age} = 35.47$ ,  $SD = 10.50$ ). Participants were paid \$0.2 for their participation.

### Results and discussion

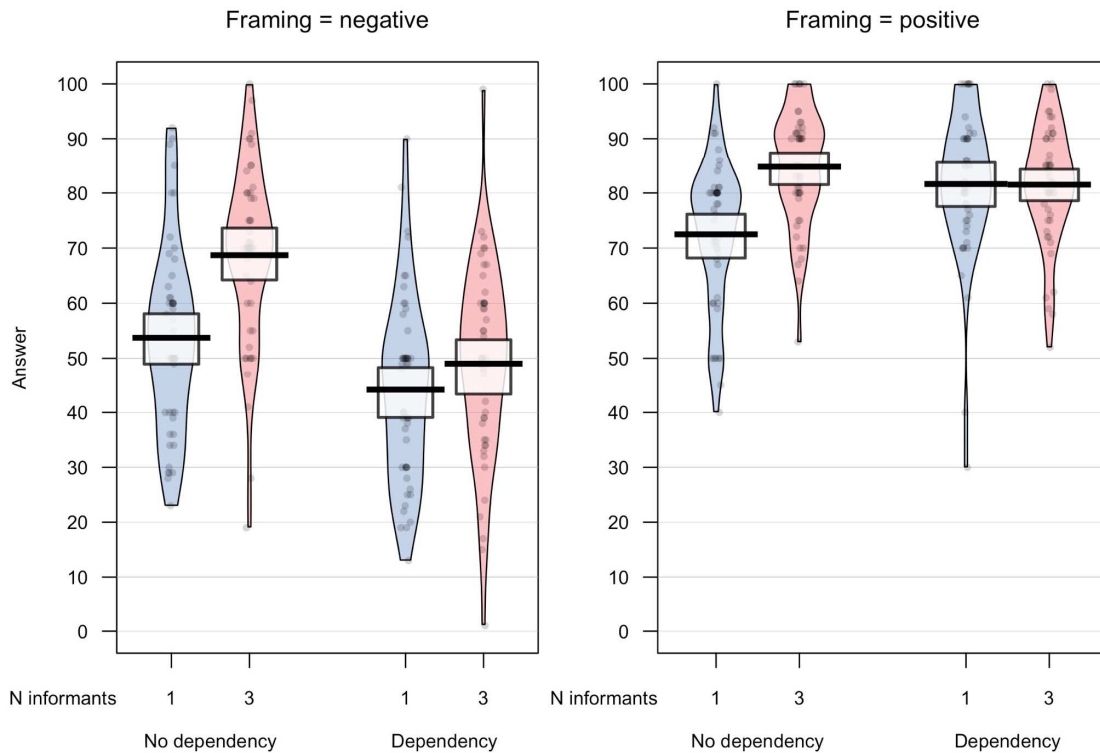


Figure 4. Ratings provided by participants in the replication of Experiment 2 (see Figure 1 for explanations).

Figure 4 displays the results of the replication of Experiment 2. The detailed analyses can be found in the ESM. The interaction between Dependency and Number of informants was again significant,  $F(1, 392) = 14.418$ ,  $p < .001$ ,  $\eta_p^2 = .035$ . These results confirm the validity of H2.

### Experiment 3

The goal of this experiment is to test the following hypothesis:

## CUES TO INFORMATIONAL DEPENDENCY

H3: People take informational dependencies into account when they stem from common motivational biases (motivational dependencies).

As in Experiment 1, participants are provided with the opinions of either one (One informant condition) or three informants (Three informants condition) regarding a fictitious restaurant. The participants then have to rate the restaurant, with the information provided by the informants as only basis. The degree of dependency between the informants' opinions is manipulated: in the No Dependency condition, the opinions appear independent, whereas in the Dependency condition, they are dependent as all three informants have the same personal relationship with the restaurant's owner. As in Experiment 1, we also manipulate whether the opinions are positive or negative.

### *Methods*

#### Participants

395 participants were recruited through Amazon Mechanical Turk (164 females,  $M_{age} = 32.46$ ,  $SD = 9.33$ ). Participants were paid \$0.2 for their participation.

#### Design

After completing a consent form, participants read a short vignette and answered one question related to it, before providing some simple demographic information. All variables were manipulated between-participants: each participant only read a single vignette.

#### Materials

The vignettes from the negative framing can be found in Table 3, the equivalent positive framing in the ESM.

	No dependency	Dependency (motivational)
--	---------------	---------------------------

CUES TO INFORMATIONAL DEPENDENCY

<p>1 Informant</p>	<p>You meet your friend Julia, and you ask her about a new restaurant that opened in your neighborhood. She tells you of the new restaurant: “I don’t think it’s great.”</p>	<p>You meet your friend Julia, and you ask her about a new restaurant that opened in your neighborhood. You know that Julia is friends with the owner of another restaurant nearby that is in direct competition with the new restaurant. She tells you of the new restaurant: “I don’t think it’s great.”</p>
<p>3 Informants</p>	<p>You meet your friend Julia, Rob, and Olivia, and you ask them about a new restaurant that opened in your neighborhood. They tell you of the new restaurant:           Julia: “I don’t think it’s great.”           Rob: “I don’t think it’s great either.”           Olivia: “I agree it isn’t great.”</p>	<p>You meet your friend Julia, Rob, and Olivia, and you ask them about a new restaurant that opened in your neighborhood. You know that Julia, Rob, and Olivia are friends with the owner of another restaurant nearby that is in direct competition with the new restaurant. They tell you of the new restaurant:           Julia: “I don’t think it’s great.”           Rob: “I don’t think it’s great either.”           Olivia: “I agree it isn’t great.”</p>

Table 3. Vignettes from the negative framing conditions of Experiment 3.

*Results and discussion*

## CUES TO INFORMATIONAL DEPENDENCY

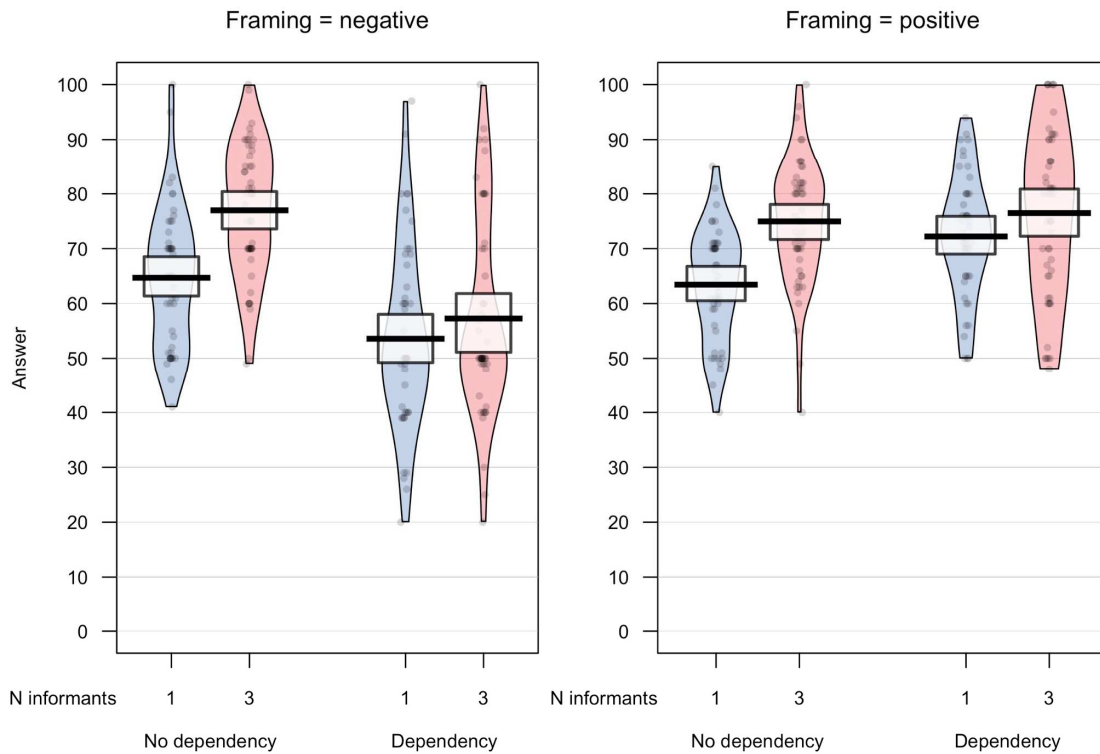


Figure 5. Ratings provided by participants in Experiment 3, in which the dependency was due to common motivation (see Figure 1 for explanations).

Figure 5 provides the results of Experiment 3. As H1 and H2, H3 predicts that participants, in rating the restaurant, should take the number of informants into account more when their opinions are independent of each other, so that we should observe an interaction between the number of informants (One, Three) and the degree of dependency (Dependency, No Dependency).

A Three-Way analysis of variance (ANOVA) was conducted on the influence of three independent variables (Dependency, Number of Informants, Framing) on the ratings the participants gave to the restaurant. This 2 (Dependency) x 2 (Number of Informants) x 2 (Framing) analysis yielded: a significant main effect of Dependency  $F(1, 387) = 13.49, p < .001, \eta_p^2 = .034$ , No Dependency ( $M = 70.02, SE = 0.993$ ), Dependency ( $M = 64.89, SE = 0.980$ ); a significant main effect of Number of

## CUES TO INFORMATIONAL DEPENDENCY

Informants,  $F(1, 387) = 32.40, p < .001, \eta_p^2 = .077$ , One Informant ( $M = 63.48, SE = 1.001$ ), Three Informants ( $M = 71.43, SE = 0.973$ ); a significant main effect of Framing,  $F(1, 387) = 38.31, p < .001, \eta_p^2 = .090$ , Positive ( $M = 71.77, SE = 0.989$ ), Negative ( $M = 63.13, SE = 0.985$ ). The critical interaction between Dependency and Number of informants was significant,  $F(1, 387) = 8.07, p < .001, \eta_p^2 = .020$ .

As predicted by H3, participants were able to take informational dependencies due to common motivation into account: they put less weight on the opinion of three informants, relative to the opinion of one informant, when the opinion of the three informants could all have been influenced by the same motivation.

### **Replication of Experiment 3**

This is an exact replication of Experiment 3, with the same design and materials.

#### Participants

397 participants were recruited through Amazon Mechanical Turk (199 females,  $M_{age} = 37.15, SD = 12.03$ ). Participants were paid \$0.2 for their participation.

#### *Results and discussion*

## CUES TO INFORMATIONAL DEPENDENCY

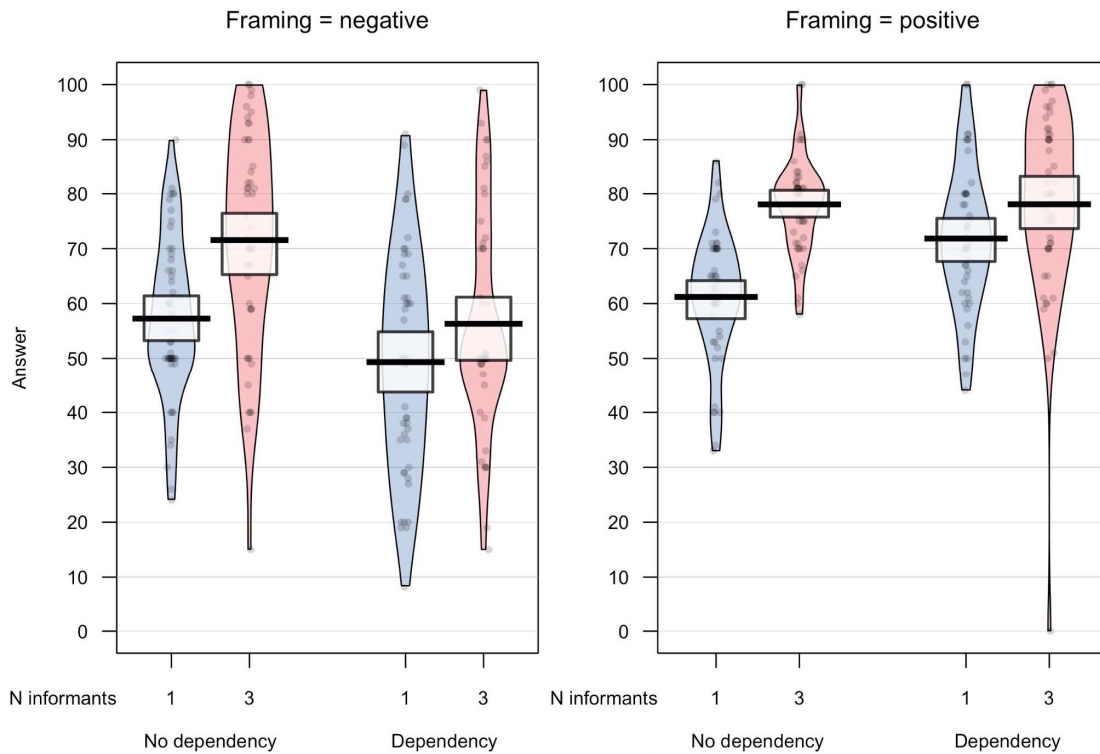


Figure 6. Ratings provided by participants in the replication of Experiment 3 (see Figure 1 for explanations).

Figure 6 displays the results of the replication of Experiment 3. The detailed analyses can be found in the ESM. The interaction between Dependency and Number of informants was again significant,  $F(1, 389) = 7.69, p < .001, \eta_p^2 = .019$ . These results support H3.

### Experiment 4

The goal of this experiment is to test the following hypothesis:

H4: People do not take informational dependencies into account when they stem from similarities in the cognitive makeup of individuals (cognitive dependencies).

## CUES TO INFORMATIONAL DEPENDENCY

As in Experiments 1 and 3, participants are provided with the opinions of either one (One informant condition) or three (Three informants condition) informants regarding a fictitious restaurant. The participants then have to rate the restaurant, with the information provided by the informants as only basis. The degree of dependency between the informants' opinions is manipulated: the opinions are either independent (No Dependency condition) or dependent as all three informants have the same tastes (Dependency condition). As in the previous experiments, we also manipulate whether the opinions are positive or negative (Positive / Negative framing conditions).

### *Methods*

#### Participants

403 participants were recruited through Amazon Mechanical Turk (205 females,  $M_{age} = 37.45$ ,  $SD = 12.09$ ). Participants were paid \$0.2 for their participation.

#### Design

After completing a consent form, participants read a short vignette and answered one question related to it, before providing some simple demographic information. All variables were manipulated between-participants: each participant only read a single vignette.

#### Materials

The vignettes from the negative framing can be found in Table 4, the equivalent positive framing in the ESM.

	No dependency	Dependency (hearsay)
1 Informant	You meet your friend Julia, and you ask her about a new	You meet your friend Julia, and you ask her about a new restaurant that

CUES TO INFORMATIONAL DEPENDENCY

	restaurant that opened in your neighborhood. She tells you: "I don't think it's great."	opened in your neighborhood. She tells you: "I don't think it's great."
3 Informants	You meet your friends Julia, Rob, and Olivia, and you ask them about a new restaurant that opened in your neighborhood. They tell you: Julia: "I don't think it's great." Rob: "I don't think it's great either." Olivia: "I agree it isn't great."	You meet your friends Julia, Rob, and Olivia, and you ask them about a new restaurant that opened in your neighborhood. You know that Julia, Rob, and Olivia have very similar tastes in food. They tell you: Julia: "I don't think it's great." Rob: "I don't think it's great either." Olivia: "I agree it isn't great."

Table 4. Vignettes from the negative framing conditions of Experiment 4.

*Results and discussion*



## CUES TO INFORMATIONAL DEPENDENCY

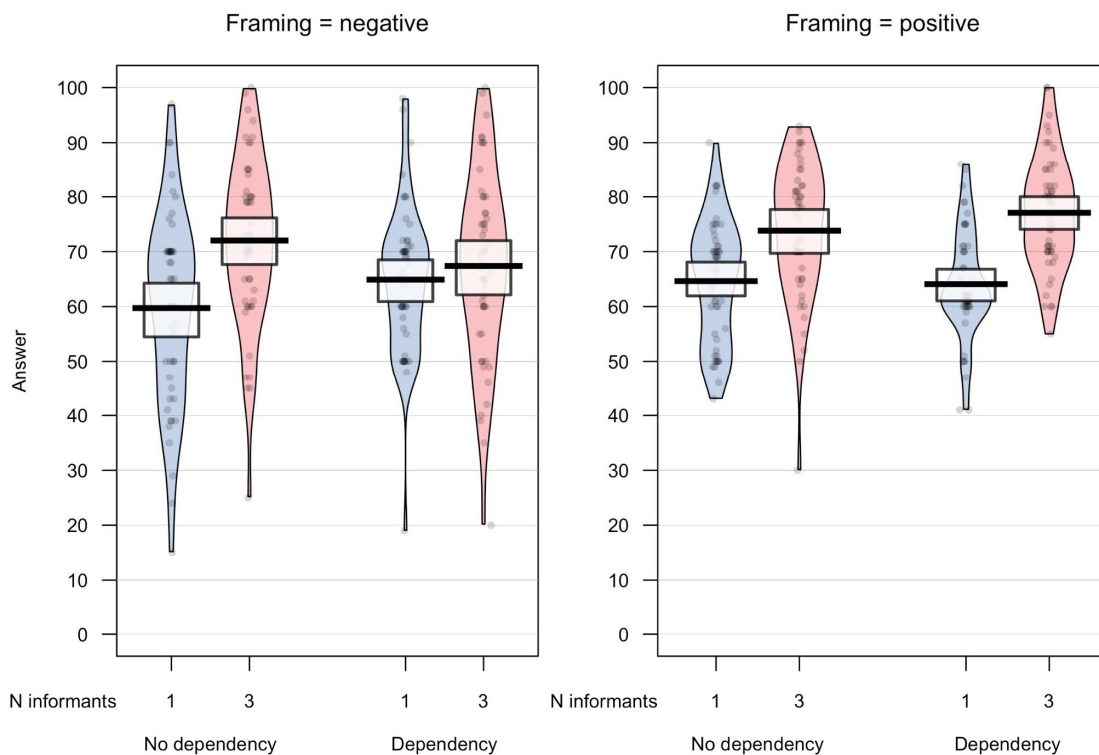


Figure 7. Ratings provided by participants in Experiment 4, in which the dependency was due to cognitive similarity (see Figure 1 for explanations).

Figure 7 provides the results of Experiment 4. By contrast with H1, H2, and H3, H4 predicts that participants, in rating the restaurant, will not take the number of informants into account more when their opinions are independent of each other: the difference in the ratings between the One and the Three informants conditions should *not* be larger in the No Dependency condition than in the Dependency condition. This means that, contrary to all previous three experiments, we should not observe an interaction between the number of informants (One, Three) and the degree of dependency (Dependency, No Dependency).

A Three-Way analysis of variance (ANOVA) was conducted on the influence of three independent variables (Dependency, Number of Informants, Framing) on the ratings the participants gave to the restaurant. This 2 (Dependency) x 2 (Number of

## CUES TO INFORMATIONAL DEPENDENCY

Informants) x 2 (Framing) analysis yielded: no significant main effect of Dependency  $F(1, 395) = 0.35, p = .554, \eta_p^2 = .001$ , No Dependency ( $M = 67.55, SE = 0.976$ ), Dependency ( $M = 68.36, SE = 0.973$ ); a significant main effect of Number of Informants,  $F(1, 395) = 45.00, p < .001, \eta_p^2 = .102$ , One Informant ( $M = 63.33, SE = 0.976$ ), Three Informants ( $M = 72.58, SE = 0.973$ ); a significant main effect of Framing,  $F(1, 395) = 7.98, p = .005, \eta_p^2 = .020$ , Positive ( $M = 69.90, SE = 0.973$ ), Negative ( $M = 66.01, SE = 0.976$ ). As predicted, the interaction between Dependency and Number of informants was not significant,  $F(1, 395) = 1.185, p = .277, \eta_p^2 = .003$ .

Participants did not take informational dependencies due common cognitive traits into account—in accordance with H4. Given that Experiments 1 to 3, and their replications, managed to detect the expected interactions, the current design and sample size should have been able to detect at least a similarly powerful effect.

### **Replication of Experiment 4**

This is a straight replication of Experiment 4, with exactly the same design and materials.

#### Participants

398 participants were recruited through Amazon Mechanical Turk (201 females,  $M_{age} = 37.18, SD = 11.41$ ). Participants were paid \$0.2 for their participation.

#### *Results and discussion*

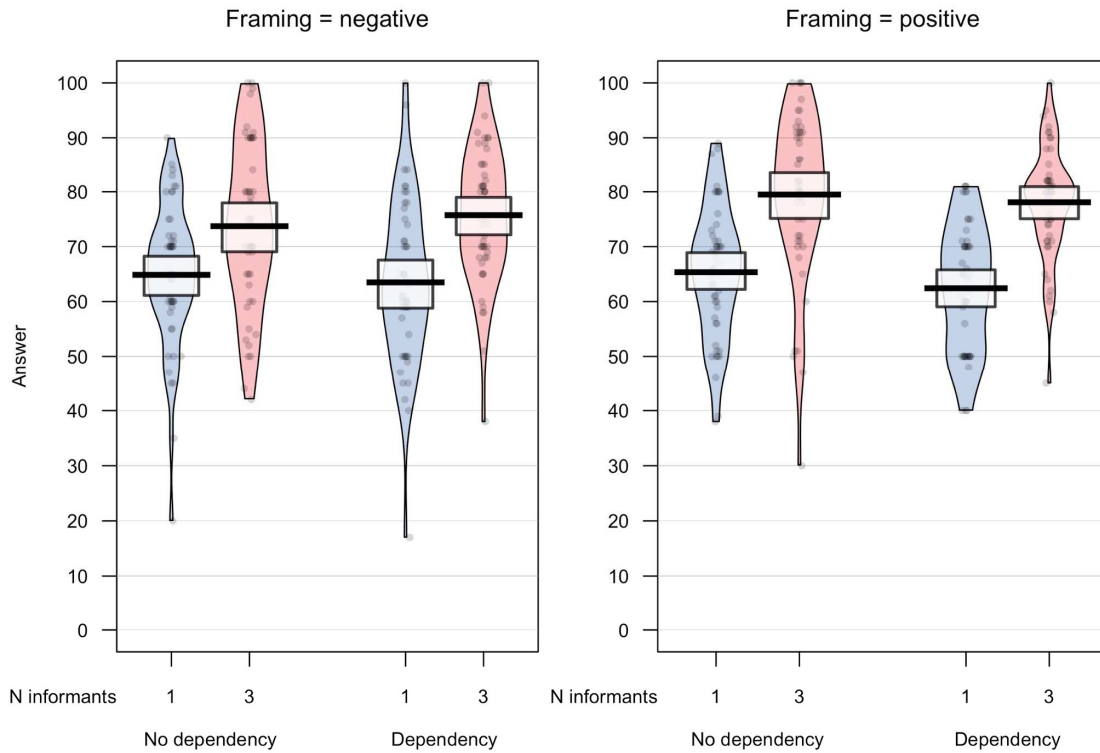


Figure 8. Ratings provided by participants in the replication of Experiment 4 (see Figure 1 for explanations).

Figure 8 displays the results of the replication of Experiment 4. The detailed analyses can be found in the ESM. The interaction between Dependency and Number of informants was again significant,  $F(1, 390) = 0.851, p = .357, \eta_p^2 = .002$ . Again, this supports H4.

### Experiment 5

The goal of this experiment is to test the following hypothesis:

## CUES TO INFORMATIONAL DEPENDENCY

H5: People discount majority opinions when a few members of the majority are suspected of not being trustworthy, compared to a situation in which no such suspicion arises.

Participants are provided with the opinions of either one, two, or three informants (One, Two, and Three informants conditions) regarding either the accused in a trial (Trial condition), or the position of troops in war (Scouts condition). Compared to the previous experiments, three changes are made. First, the number of informants is more finely graded (1, 2, or 3 instead of 1 or 3), so that we can observe whether treating one informant as untrustworthy is similar to simply ignoring this informant. Second, in one condition we suggest that one of the informants is untrustworthy (in the case of the trial vignettes, by saying they are friends with the accused). Third, constructing a negative framing version of the trial vignettes being difficult, we offer an altogether different scenario instead, to play the same role of robustness check as the negative framings in the other experiments.

### *Methods*

#### Participants

888 participants were recruited through Amazon Mechanical Turk (397 females,  $M_{age} = 34.27$ ,  $SD = 10.98$ ). Participants were paid \$0.2 for their participation.

#### Design

After completing a consent form, participants read a short vignette and answered one question related to it, before providing some simple demographic information. All variables were manipulated between-participants: each participant only read a single vignette.

## CUES TO INFORMATIONAL DEPENDENCY

### Materials

The vignettes from the trial framing can be found in Table 5, the equivalent scout framing in the ESM. All trial vignettes started with: "Imagine that you are a juror in a trial. The accused stands trial for robbing a jewelry store." Participants were asked: "Do you think the accused was at the auto repair shop?" They had to provide a numerical answer from 0 to 100.

	No dependency	Dependency (one untrustworthy informant)
1 Informant	One of the witnesses says: "I saw him at an auto repair shop on the other side of town at the time of the robbery."	One of the witnesses says: "I saw him at an auto repair shop on the other side of town at the time of the robbery."  This witness is a good friend of the accused.
2 Informants	Here is what some of the witnesses say:  First witness: "I saw him at an auto repair shop on the other side of town at the time of the robbery."  Second witness: "I also saw him at that auto repair shop at the time of the robbery."	Here is what some of the witnesses say:  First witness: "I saw him at an auto repair shop on the other side of town at the time of the robbery."  Second witness: "I also saw him at that auto repair shop at the time of the robbery."  One of these two witnesses is a good friend of the accused.
3 Informants	Here is what some of the	Here is what some of the witnesses

CUES TO INFORMATIONAL DEPENDENCY

	<p>witnesses say:</p> <p>First witness: "I saw him at an auto repair shop on the other side of town at the time of the robbery."</p> <p>Second witness: "I also saw him at that auto repair shop at the time of the robbery."</p> <p>Third witness: "I was there too, and I saw him in that auto repair shop."</p>	<p>say:</p> <p>First witness: "I saw him at an auto repair shop on the other side of town at the time of the robbery."</p> <p>Second witness: "I also saw him at that auto repair shop at the time of the robbery."</p> <p>Third witness: "I was there too, and I saw him in that auto repair shop."</p> <p>One of these three witnesses is a good friend of the accused.</p>
--	--	---

*Table 5.* Vignettes from the trial framing conditions of Experiment 5.

*Results and discussion*

## CUES TO INFORMATIONAL DEPENDENCY

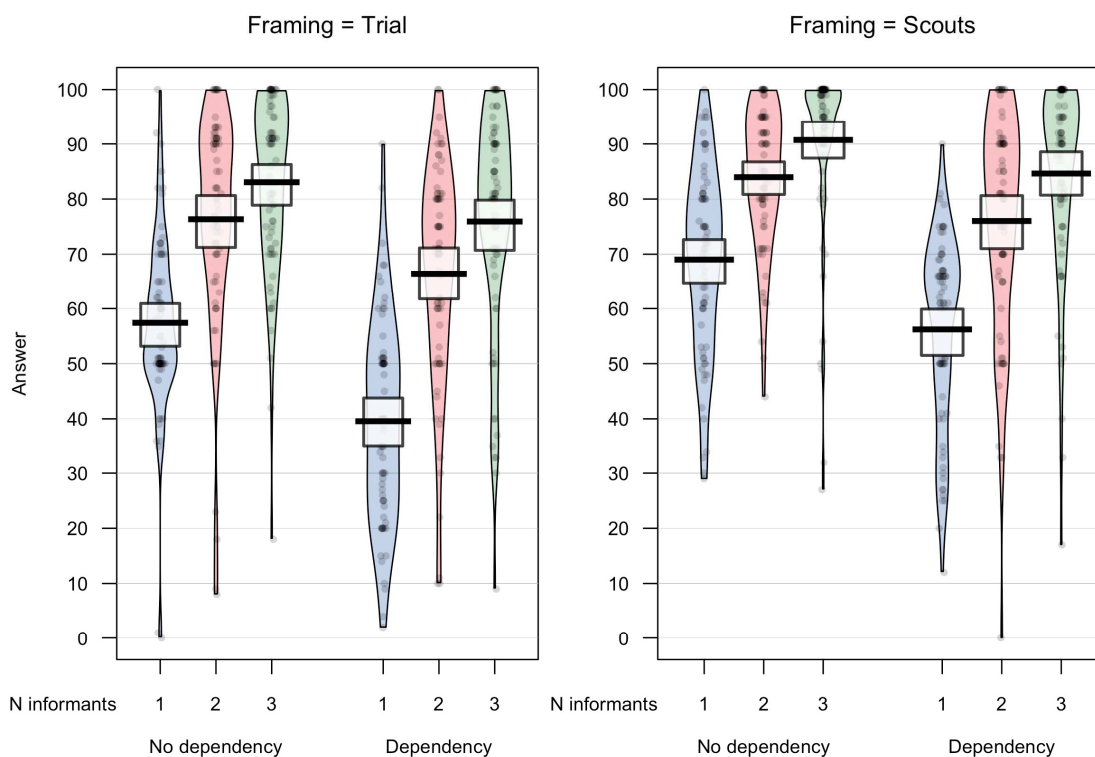


Figure 9. Ratings provided by participants in Experiment 5 (see Figure 1 for explanations).

Figure 9 provides the results of Experiment 5. H5 predicts that participants, in deciding whether to trust the witnesses, should largely discount the testimony of the one untrustworthy witness. This means that we should observe the following effects: (1) a main effect of number of witnesses (on the whole, more witnesses make for a more reliable testimony); (2) a main effect of Dependency (lower weight put on the witnesses' testimony if one of them is untrustworthy); (3) an interaction effect (the difference between the No Dependency and the Dependency conditions should decrease as the number of witnesses increases, since the proportion of untrustworthy witnesses also decreases).

A Three-Way analysis of variance (ANOVA) was conducted on the influence of three independent variables (Dependency, Number of Informants, Framing) on how much participants believed the witnesses or the scouts. This 2 (Dependency) x 3

## CUES TO INFORMATIONAL DEPENDENCY

(Number of Informants) x 2 (Framing) analysis yielded: a significant main effect of Dependency  $F(1, 876) = 73.95, p < .001, \eta_p^2 = .078$ , No Dependency ( $M = 76.75, SE = 0.846$ ), Dependency ( $M = 66.46, SE = 0.846$ ); a significant main effect of Number of Informants,  $F(2, 876) = 193.70, p < .001, \eta_p^2 = .307$ , One Informant ( $M = 55.55, SE = 1.045$ ), Two Informants ( $M = 75.69, SE = 1.036$ ), Three Informants ( $M = 83.58, SE = 1.027$ ); a significant main effect of Framing,  $F(1, 876) = 74.22, p < .001, \eta_p^2 = .078$ , Trial ( $M = 66.45, SE = 0.844$ ), Scouts ( $M = 76.76, SE = 0.848$ ). The interaction between Dependency and Number of informants was significant,  $F(2, 876) = 4.72, p = .009, \eta_p^2 = .011$ .

Moreover, H5 predicts that, in the Two and Three informants conditions, participants trust the witnesses less when one of them is untrustworthy (Dependency condition) rather than when all of them are trustworthy (No dependency condition).

Combining the two framings, and the Two and Three informants conditions, the post-hoc comparison between the Dependency and the No dependency condition is significant ( $t(595) = 5.05, p < .001$ , Cohen's  $d = .41$ ).

As predicted by H5, participants were able to take informational dependencies due to untrustworthiness into account: they largely discounted the opinion of an untrustworthy informant, even if their opinion converged with the opinion of trustworthy informants.

### **Replication of Experiment 5**

This is a straight replication of Experiment 5, with exactly the same design and materials.

#### Participants

988 participants were recruited through Amazon Mechanical Turk (513 females,  $M_{age} = 37.47, SD = 12.29$ ). Participants were paid \$0.2 for their participation.



*Results and discussion*

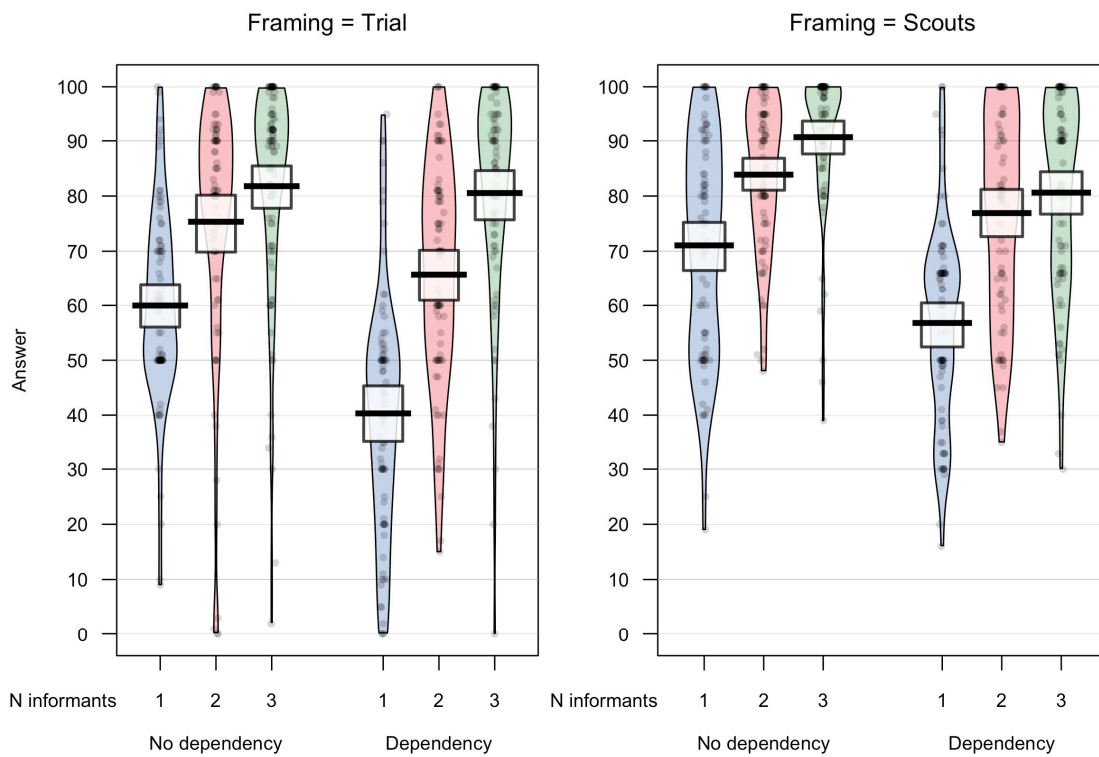


Figure 10. Ratings provided by participants in the replication of Experiment 5 (see Figure 1 for explanations).

Figure 10 displays the results of the replication of Experiment 5. A Three-Way analysis of variance (ANOVA) was conducted on the influence of three independent variables (Dependency, Number of Informants, Framing) on the ratings the participants gave to the restaurant. This 2 (Dependency) x 3 (Number of Informants) x 2 (Framing) analysis yielded: a significant main effect of Dependency  $F(1, 976) = 71.80, p < .001, \eta_p^2 = .069$ , No Dependency ( $M = 77.12, SE = 0.854$ ), Dependency ( $M = 66.82, SE = 0.864$ ); a significant main effect of Number of Informants,  $F(2, 976) = 166.28, p < .001, \eta_p^2 = .254$ , One Informant ( $M = 57.04, SE = 1.050$ ), Two Informants ( $M = 75.47, SE = 1.061$ ), Three Informants ( $M = 83.40, SE = 1.045$ ); a significant main effect of Framing,  $F(1, 976) = 59.41, p < .001, \eta_p^2 = .057$ , Trial ( $M =$

## CUES TO INFORMATIONAL DEPENDENCY

67.29, SE = 0.845), Scouts (M = 76.65, SE = 0.873). The interaction between Dependency and Number of informants was again significant,  $F(1, 976) = 7.96, p < .001, \eta_p^2 = .016$ .

Combining the two framings, and the two and three informants conditions, the post-hoc comparison between the Dependency and the No dependency condition is significant ( $t(659) = 4.42, p < .001$ , Cohen's  $d = .34$ ). These results confirm the validity of H5.

### **Conclusion**

Previous experiments have revealed that participants adequately take into account a number of cues regarding how much weight they should grant majority opinions—such as the absolute and relative size of the majority, or the competence of its members (whom we call ‘informants’) (for review, see Mercier & Morin, submitted). However, the results regarding informational dependency are much less clear. In some cases, participants appropriately discount majority opinions when the opinions of the informants have not been acquired independently. In other cases, participants fail to discount such opinions. We suggested that an evolutionary framework (Mercier & Morin, submitted; Sperber et al., 2010) could help account for these discrepancies by pointing out that some cues to informational dependencies are likely evolutionarily valid—that is, they were present and reliable in human evolution—and others not. Evolutionarily valid cues should be easily and spontaneously taken into account, while non-evolutionarily valid cues should require specific training. The existing literature seems to fit well with this framework (compare for instance: Maines, 1990; to Hu et al., 2015; for review, see Mercier & Morin, submitted).

## CUES TO INFORMATIONAL DEPENDENCY

The present article tested five novel hypotheses derived from this framework. The first three hypotheses relate to cues that people should be able to take into account when computing informational dependencies, namely: (H1) that the informants owe their beliefs to the same hearsay, (H2) that the informants owe their beliefs to having perceived the same event, (H3) that the informants owe their beliefs to a common motivation. Experiments 1, 2, and 3 (each replicated), suggest that our participants were able to take these cues into account, discounting the opinion of three informants when these cues to informational dependency were present.

The fourth hypotheses suggested that, by contrast with the cues described in hypotheses 1 to 3, cognitive dependency would not be an evolutionarily valid cue to informational dependency. In Experiment 4 (and its replication), participants did not take cognitive dependency into account when evaluating majority opinion, supporting H4. Although this is a null result, our interpretation in favor of H4 is comforted by the fact that participants were able to take a variety of other cues into account in very similar settings (Experiments 1 to 3).

Finally, the fifth hypothesis bore on a more subtle use of informational conformity. It predicted that people would not be deceived into thinking that an untrustworthy member of a majority had an equal weight to more trustworthy members simply because they supported the majority opinion. Experiment 5 (and its replication) supported this hypothesis.

This series of experiments adds to the existing literature on the role of dependency in informational conformity in three direct ways. First, it confirms, using more ecologically valid stimuli, that participants are able to take simple cues to informational dependency into account. Second, it offers, to the best of our knowledge, the first experiments bearing directly on whether participants can take

## CUES TO INFORMATIONAL DEPENDENCY

internal dependencies (cognitive or motivational) into account. Third, it offers, again to the best of our knowledge, the first experiments on the interaction between informational conformity and informant trustworthiness.

This set of experiments also argues for the fruitfulness of the distinction between evolutionarily valid cues and non-evolutionarily valid cues. Future experiments should pay special attention to whether the cues to dependency presented are evolutionarily valid or not. It should be noted that even if, in the present experiments, we have attempted to render our stimuli more ecologically valid, they still suffer from the fundamental limitations of the vignette format. For instance, participants are not directly exposed to a conversation, they are told about a conversation, and the topic at issue is of no relevance to them. We believe this limitation does not affect the interpretation of our positive results—if people can take some cues into account even in these conditions, presumably they can also do so in more ecologically valid conditions. However, it might affect the interpretation of our negative results, which might have been different in more ecologically valid conditions. Motivation has been shown to play a crucial role in the type of cues participants utilize when evaluating communicated information, with a greater reliance on more complex and reliable cues with increased motivation (e.g. Petty & Cacioppo, 1986). It is thus possible that participants would make an even finer use of cues to informational dependencies if the opinions they had to evaluate were personally relevant to them.

Finally, the fact that our experiments are not perfectly ecological—in particular, participants are given information by the experimenter, rather than being directly provided information by other people—might have produced some task demands. Participants might have guessed what we expected of them. Although we cannot

## CUES TO INFORMATIONAL DEPENDENCY

entirely rule out that possibility, the fact that all our experiments were performed between-participants, with each participant seeing a single vignette, would have made it more difficult for them to infer the goal of the experiment.

The present work could be pursued in different directions. Practically, it would be interesting to test interventions aimed at making people aware of the benefits of cognitive diversity, so they put more weight on a convergence of opinions if those whose opinions converge are more cognitively diverse. Theoretically, it would be interesting to further test the evolutionarily valid cues / non-evolutionarily valid cues distinction, for instance by directly contrasting the two types of cues in the same experiment (see, e.g. Mercier, Majima, et al., submitted).

Data accessibility statement. All our data is available at

[https://osf.io/8wbz9/?view\\_only=53b2d522b6564d39b21eb4e88e323eac](https://osf.io/8wbz9/?view_only=53b2d522b6564d39b21eb4e88e323eac)

Acknowledgments. We would like to thank Olivier Morin and Christophe Heintz for feedback on this project. H.M.'s work is supported by an Agence Nationale de la Recherche grant EUR FrontCog ANR-17-EURE-0017. H.M.'s work is supported by the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013) and ERC grant agreement no. 609819 (SOMICS).

## References

- Aikhenvald, A. Y. (2004). *Evidentiality*. Oxford: Oxford University Press.
- Bonaccio, S., & Dalal, R. S. (2006). Advice taking and decision-making: An integrative literature review, and implications for the organizational sciences. *Organizational Behavior and Human Decision Processes*, in press.
- Bond, R. (2005). Group size and conformity. *Group Processes & Intergroup Relations*, 8(4), 331–354.
- Castelain, T., Bernard, S., & Mercier, H. (2018). Evidence that Two-Year-Old Children are Sensitive to Information Presented in Arguments. *Infancy*, 23(1), 124–135.
- Condorcet. (1785). *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix*. Paris: L'imprimerie royale.
- Conradt, L., & List, C. (2009). Group decisions in humans and animals: a survey. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 364(1518), 719–742.
- Conradt, L., & Roper, T. J. (2003). Group decision-making in animals. *Nature*, 421(6919), 155–158.
- Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition*, 31(3), 187–276.
- Estlund, D. (1994). Opinion leaders, independence, and Condorcet's jury theorem. *Theory and Decision*, 36(2), 131–162.
- Harris, P. L. (2012). *Trusting what you're told: How children learn from others*. Cambridge, MA: Belknap Press/Harvard University Press.
- Harris, P. L., & Lane, J. D. (2014). Infants understand how testimony works. *Topoi*, 33(2), 443–458.
- Hastie, R., & Kameda, T. (2005). The robust beauty of majority rules in group decisions. *Psychological Review*, 112(2), 494–508.
- Henrich, J., & Boyd, R. (1998). The evolution of conformist transmission and the emergence of between-group differences. *Evolution and Human Behavior*, 19(4), 215–241.
- Hertwig, R., & Erev, I. (2009). The description-experience gap in risky choice. *Trends in Cognitive Sciences*, 13(12), 517–523.
- Hess, N. H., & Hagen, E. H. (2006). Psychological adaptations for assessing gossip veracity. *Human Nature*, 17(3), 337–354.
- Hong, L., & Page, S. E. (2004). Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences of the United States of America*, 101(46), 16385.
- Hu, J., Whalen, A., Buchsbaum, D., Griffiths, T., & Xu, F. (2015). Can Children Balance the Size of a Majority with the Quality of their Information? In *Proceedings of the Cognitive Science Society Conference*.
- Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, 77(6), 1121.
- Ladha, K. K. (1992). The Condorcet jury theorem, free speech, and correlated votes. *American Journal of Political Science*, 617–634.
- Maines, L. A. (1990). The effect of forecast redundancy on judgments of a consensus forecast's expected accuracy. *Journal of Accounting Research*, 29–47.
- Maynard Smith, J., & Harper, D. (2003). *Animal signals*. Oxford: Oxford University Press.
- Mercier, H. (submitted). *Vigilance*. New York: Princeton University Press.
- Mercier, H. (2017). How gullible are we? A review of the evidence from psychology and social science. *Review of General Psychology*, 21(2), 103.

## CUES TO INFORMATIONAL DEPENDENCY

- Mercier, H., Dockendorff, M., & Schwartzberg, M. (submitted). Democratic legitimacy and attitudes about information-aggregation procedures.
- Mercier, H., Majima, Y., Claidière, N., & Léone, J. (submitted). Obstacles to the spread of counter-intuitive beliefs.
- Mercier, H., & Morin, O. (submitted). Majority rules: how good are we at aggregating convergent opinions?
- Mercier, H., & Strickland, B. (2012). Evaluating arguments from the reaction of the audience. *Thinking & Reasoning*, 18(3), 365–378.
- Mills, C. M., & Keil, F. C. (2005). The Development of Cynicism. *Psychological Science*, 16(5), 385–390.
- Morgan, T. J. H., Rendell, L. E., Ehn, M., Hoppitt, W., & Laland, K. N. (2012). The evolutionary basis of human social learning. *Proceedings of the Royal Society of London B: Biological Sciences*, 279(1729), 653–662.
- Mutz, D. C. (1998). *Impersonal influence: How perceptions of mass collectives affect political attitudes*. Cambridge: Cambridge University Press.
- Page, S. (2007). *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton: Princeton University Press.
- Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (pp. 123–205). Orlando, FL: Academic Press.
- Reyes-Jaquez, B., & Echols, C. H. (2015). Playing by the rules: Self-interest information influences children's trust and trustworthiness in the absence of feedback. *Cognition*, 134, 140–154.
- Richerson, P. J., & Boyd, R. (2005). *Not by genes alone*. Chicago: University of Chicago Press.
- Snizek, J. A., Schrah, G. E., & Dalal, R. S. (2004). Improving judgement with prepaid expert advice. *Journal of Behavioral Decision Making*, 17(3), 173–190.
- Sperber, D., Clément, F., Heintz, C., Mascaro, O., Mercier, H., Origgi, G., & Wilson, D. (2010). Epistemic vigilance. *Mind and Language*, 25(4), 359–393.
- Sterelny, K. (2003). *Thought in an Hostile World*. Oxford, UK: Blackwell.
- Strandburg-Peshkin, A., Farine, D. R., Couzin, I. D., & Crofoot, M. C. (2015). Shared decision-making drives collective movement in wild baboons. *Science*, 348(6241), 1358–1361.
- Tomasello, M. (2010). *Origins of human communication*. Cambridge: MIT press.
- Tooby, J., Cosmides, L., & Price, M. E. (2006). Cognitive adaptations for n-person exchange: the evolutionary roots of organizational behavior. *Managerial and Decision Economics*, 27(2–3), 103–129.
- Whalen, A., Buchsbaum, D., Griffiths, T. L., & others. (2013). How do you know that? Sensitivity to statistical dependency in social learning. In *Proceedings of the 35th annual meeting of the Cognitive Science Society, Berlin, Germany*. Retrieved from <https://mindmodeling.org/cogsci2013/papers/0297/paper0297.pdf>
- Whalen, A., Griffiths, T. L., & Buchsbaum, D. (2018). Sensitivity to shared information in social learning. *Cognitive Science*, 42(1), 168–187.
- Yousif, S. R., Aboody, R., & Keil, F. C. (2018). Any consensus will do: The failure to distinguish between 'true' and 'false' consensus. In *Proceedings of the Cognitive Science Society Conference*.