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Noise, bias, and expertise: the dynamics of becoming informed

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> Not only in research, but also in the everyday world of politics and economics, we would all be better off if more people realised that simple nonlinear systems do not necessarily possess simple dynamical properties.
>
> Robert M. May (1976: 467)

The dynamics of diffusion and persuasion, as well as the manner in which these processes are affected by expert opinion leaders, play key issues in democratic politics. Moreover, the roles of experts and activists are particularly important in communication processes characterized by noisy and biased information, playing central roles in processes where people with variable levels of expertise and preference strength select informants, as well as being influenced by them. This chapter and the next are based on an experimental approach that addresses these problems at multiple levels of observation in a highly dynamic context – small groups of individuals communicating with one another in real time. The role of opinion leaders within the communication process is further heightened by two factors: (1) the higher value placed by participants on expert informants, which in turn exposes recipients to heterogeneous and potentially influential streams of information, and (2) the temporal persistence of judgments and opinions among those individuals who have invested more heavily in the acquisition of information.

Our argument is based on a model of electorates in which complex networks give rise to communication among interdependent individuals with heterogeneous preferences and levels of expertise. These individuals, in turn, both produce and encounter streams of information that are frequently noisy and biased. Such a model raises important questions regarding the dynamics of becoming informed. How do individuals balance their own individually acquired information with information they receive from others? Do individuals evaluate new information in the context of old information (Lodge and Taber 2000; Huckfeldt, Johnson, and Sprague 2004), or do they discard the old in favor of

the new? Is the time-dependence of information and communication affected by individual expertise, by the reliance on socially mediated information, and/or by the heterogeneity of incoming information streams? What are the consequences of such temporal dependence for the social diffusion of information?

This chapter addresses these questions based on a small group experiment that implements variations in information costs across individuals, as well as making it possible to obtain information from others through a sequential series of social exchanges. The experiment provides incentives for individuals to become informed, but these incentives must be assessed relative not only to information costs, but also to the noise and bias attached to the information. On this basis we gain new insight regarding the influence of opinion leaders, as well as the dynamics of opinion leadership.

EXPERTISE, INFORMATION COSTS, AND INTERDEPENDENT CITIZENS

Due to the individually variable costs of becoming informed, one might expect democratic politics to be driven by a cadre of self-appointed experts within the electorate – individuals for whom the problem of information costs is greatly reduced, or for whom these costs do not apply. These experts are self-appointed because their roles are self-defined by their own interests and preferences in relationship to the value of political information. Having already paid the costs of becoming informed, the well-informed are more likely to be politically engaged across a range of political activities, including the process of communicating their views to others (Huckfeldt and Mendez 2008).

Such a view is premature for several reasons, and it runs the risk of exaggerating the net influence of single experts. First, many individuals receive multiple conflicting messages from experts with divergent viewpoints, and hence it is not that experts are necessarily lacking in influence, but rather that their messages must compete with other conflicting messages. Second, the recipients of messages are active participants in the communication process even when their supply of information is quite limited, and hence it becomes important to take into account the role of both the senders and the recipients of information in the communication process. In particular, individual information-processing strategies play a central role within communication networks, making it important to focus on the "nodes" as well as the "edges" – to address the role of individual recipients and communicators, as well the relationships that tie them to one another. This becomes particularly important relative to the value that recipients place on the information provided by alternative informants.

Downs' (1957) analysis assumes the importance of politically expert associates with compatible political orientations, but important problems relate to the identification and verification of an informant's expertise and trustworthiness (Boudreau 2009; Lupia and McCubbins 1998). Snowball surveys of

naturally occurring communication networks show that individuals *do* communicate about politics more frequently with individuals whom they judge to be politically knowledgeable. Just as important, their perceptions of expertise among others are driven by the objectively verified expertise of potential informants – that is, they are typically quite accurate in recognizing the political preferences of those who are politically expert and engaged. These snowball surveys also show that the perceptions of expertise held by others, as well as the reported frequencies of political discussion, are only modestly affected by political agreement (Huckfeldt 2001; Huckfeldt, Sprague, and Levine 2000).

Moreover, when subjects in laboratory experiments are given the opportunity to obtain political information from other subjects, they place a greater emphasis on the expertise of other subjects rather than the presence of shared political preferences (see Chapters 7, 8, and 9). Similarly, in field experiments that address the natural formation of communication networks, both Lazer et al. (2010) and Levitan and Visser (2009) identify the minor role played by compatible political views in the formation of associational networks. In short, there is scant evidence to suggest that individuals exercise lock-grip control to avoid association with individuals holding preferences that are different from their own (see Huckfeldt and Sprague 1995; Huckfeldt, Johnson, and Sprague 2004). Thus, we turn to the role of the communication process itself to understand the manner in which noise and bias are filtered by the communication process within associational networks.

MEMORY CONSTRAINTS ON THE PROCESS OF BECOMING INFORMED

Time and the organization of human memory produce their own constraints on political communication and the process of becoming informed. Limitations on the capacity of working memory mean that individuals are continually storing and retrieving information in long-term memory, and information that is seldom retrieved becomes increasingly more difficult to recall. Time is certainly not the only factor affecting the accessibility of information from long-term memory. Some information is more compelling (and hence retrievable) than other information, due to both the inherent characteristics of the information and the correspondence between information characteristics and the cognitive map of the individual (Fazio 1995; Berent and Krosnick 1995). While time might play a potentially important and systematic role in the process, expectations diverge regarding the exact nature of the role, as well as the direction, of temporal effects.

First, as a counterfactual baseline, to the extent that individuals engage in memory-based processing with infinitely accurate recall, the first piece of information obtained in reaching a judgment should be as important as the last piece of information. More realistically, to the extent that individuals engage in memory-based processing with finite recall, we would expect a recency effect in which more recent information should have the greatest consequence.

Second, if the process of becoming informed is autoregressive (Huckfeldt, Johnson, and Sprague 2004), new information is processed in the context of old information. Hence, new information is less likely to be influential to the extent that it diverges from old information. In the context of memory decay, however, a persistent shift in the message being communicated ultimately swamps earlier signals in favor of more recent ones. In this way, an autoregressive process in the context of memory decay produces a complex moving average of messages, autoregressively upweighting earlier messages but simultaneously downweighting due to decay.

Finally, an on-line processing model employs an autoregressive framework in which new information is judged in the context of old information (Lodge and Taber 2000), but in this instance the effect of old information is summarized and consolidated in the form of a tally – an attitude or judgment that the individual brings to the interpretation of new information. When an individual receives new information in the on-line model, it is judged relative to prior judgments based on earlier information. In this case we see a primacy effect in which new information is less likely to be influential to the extent that (1) the pre-existent judgment is held more confidently and (2) the new information diverges from the old information. Here again, the primacy effect of earlier messages must compete with memory decay.

We rely on the early insights of McPhee's (1963) analysis in addressing the implications of social communication, political expertise, and memory decay for the political communication process. In his computer simulation, agents take information from sources in the environment, such as the news media. They form prior judgments on the basis of that information and share their opinions with others. Based on these communications, they update these priors and communicate again, in a repeated series of communications and updates. We pursue McPhee's contributions in the context of an experimental design and analysis that is inspired by a continuing stream of work in the study of social dilemmas (Ostrom, Gardiner, and Walker 1992; Fehr and Gächter 2002; Ahn, Isaac, and Salmon 2009).

THE EXPERIMENTAL DESIGN

Studies of political communication through social networks are beset by two related problems. First, social networks involve explicitly endogenous processes. You choose your associates subject to contextually constrained supply, and then your associates influence you. Hence, it is difficult to separate the influence of network construction from the influence of information transmission within and through networks.[1] Second, communication is not an isolated event, but rather a series of interdependent events best understood as a process that unfolds in time.

[1] Not all networks are endogenous to the choices of the participants, and indeed important experimental work has focused on the implications of exogenously imposed networks (see Kearns et al.

In this chapter and the next, we modify the design of our experimental framework to accommodate repeated interaction and communication, as well as their effects on participant judgments in real time. Our goal is to approximate the repeated and influential social interactions underlying the complex communication processes and individual interdependence occurring within social networks.

The experimental setting is once again based on a mock election with two "candidates" who are not real human subjects, but are represented as positions on a one-dimensional policy space. The preference space varies from 1 to 7, where each participant has a unique integer position that remains constant across the periods in an experimental session, but candidate positions are reset at each period. The participant's goal in each period is to elect the "candidate" most closely matching her own position on the same dimension, and she is rewarded with a cash incentive if the closest candidate to her wins the election at that period. The exact positions of the candidates are not known to the voters, thereby creating an incentive to obtain information. Privately obtained information incurs costs, and these costs are also assigned randomly to participants. In order to minimize costs, participants have an opportunity to obtain free information from other participants, and to employ public information that is also free.

Seven subjects participate in each experimental session, where one subject in each session holds each of the positions from 1 through 7. Two subjects pay nothing for privately purchased information, two subjects pay 5 Experimental Currency Units (ECUs), and three subjects pay 20 ECUs. Verbal communication was not allowed during the experiment, and all decisions and information exchanges were made using desktop computers. All participants were identified by their unique participant numbers, and thus they are not able to match these numbers to the true identities of the other participants in the experimental lab.

THE EXPERIMENTAL PROCEDURE

Each experimental session lasts for approximately one hour, and includes an average of 9 periods. A new election with new candidate positions occurs at each period, but the subjects' randomly assigned information costs and preferences are held constant for the entire session. Before an experimental session begins, participants are randomly assigned integer preferences and information costs that remain unchanged for the duration of the experiment.[2] Additionally, all participants are informed that Candidate A's position is between 1 and 6, while

2009; and Chapter 8 of this book). Most work in political communication has addressed networks that are endogenous to individual choice, and that is the literature we address here. Our argument is that, even when individuals are given control over network construction, their choices often are constrained by larger social contexts and their own competing priorities.

[2] The relationship between information costs and preferences is established randomly as well, but it is held constant across experimental sessions. Hence every session has the following cost, preference pairings: 1, 20; 2, 5; 3, 20; 4, 0; 5, 5; 6, 20; 7, 0.

Candidate B's position is between 2 and 7. Then, in each of the approximately 9 periods per session, the following steps occur:

1. Participants receive 100 ECUs, of which 50 ECUs can be spent on information. (Hence, subjects with an information cost of 20 ECUs can purchase only two "pieces" of information.)
2. The two candidates' positions are drawn from the respective intervals.
3. Participants may purchase ***private information*** at their assigned cost.
4. After the subjects receive the information, they are asked to provide a prior judgment regarding each candidate's position, and they are truthfully told that their judgments will not be communicated to other participants.
5. A new computer screen shows each participant the preferences and the amounts of private information that each of the participants has purchased. Based on this information, subjects are allowed to make a first request for ***social information*** from one other subject. This request for social information is free to the sender and receiver. Potential informants are not required to comply with the request, and they are told that they need not provide the same information to all requestors. Participants almost always agree to provide information, consisting of a single message with information regarding each candidate position.
6. After receiving the information, subjects are asked to update their prior judgments – to offer a new judgment regarding the position of the candidate.
7. Steps 5 and 6 are repeated two more times. Hence, subjects have the opportunity to make three information requests from other subjects, and they update their priors at each step. This produces a series of four judgments regarding the candidates' positions: a prior judgment after purchasing private information but before communication, as well as three updates after each of three communications with other participants. It is important to emphasize that ***the subjects are never provided with a summary of the information they have received.*** To the contrary, they assess and evaluate the information as it becomes available and they never have subsequent access. All information is thus provided sequentially and incrementally, and the subject's challenge is to integrate and assess the information.
8. After communication is completed, the participants record their last updated prior, and they are provided with an opportunity to purchase a single piece of information at a cost of 10 ECUs.
9. The participants cast their votes, and the outcome of the election is revealed. If the winning candidate's position is closer to a voter than the losing candidate's position, the voter earns 50 extra ECUs. If the winning candidate's position is farther away from the voter's position than the losing candidate's position, 50 ECUs are subtracted from the voter's

account. If candidates are equally distant from the voter, the voter neither gains nor loses. A voter could thus earn as much as 150 ECUs in a period, but only if she did not purchase any information (or if her information cost was zero). The minimum payoff is 0 ECUs – when a voter spends 50 ECUs on purchasing information and her candidate loses the election.

10. Participants are informed of their net earnings, which accumulate across periods.
11. Candidate positions are reset, and participants proceed to the next period. At the end of the experimental session, subjects are paid the show-up fee plus their total earnings in cash, where 100 ECUs equals U.S.$1.00. The range of total earnings, including the show-up fee, is from $8.00 to $17.00, and the mean earning is $12.00.

In summary, the participants thus have three potential sources of information on which to base their judgments regarding the candidates. First, the public information that the two candidates' positions are drawn from different intervals could potentially help a voter in the absence of other forms of information.[3] Second, voters are allowed to purchase unbiased but noisy private information on candidates' true positions. Third, each participant has an opportunity to request social information from other participants – information that is both noisy and potentially biased. That is, the requestor depends not only on the reliability of information that serves as the basis for *the informants'* judgments, but also on the ability and willingness of the informant to compile and provide the information in an unbiased manner.

The proximate consequences of the experimental manipulations meet our expectations. Participants with higher costs obtain less private information, and participants who purchase more private information are better able to make informed choices. Mean information purchases are 2.8, 1.9, and 1.2 for subjects with costs of 0, 5, and 20 ECUs. Simple regressions of subjects' *final judgments* regarding Candidate A's position on the candidate's *true* positions produce slope coefficients of .64 (t=13.6) for those who purchased 3 or 4 pieces of information, .54 (t=9.4) for those who purchased 2, and .25 (t=4.7) for those who purchased 0 or 1.

Our interests reach beyond these first-order consequences, however. The communication process is complex, based on interdependent actors, and participants cannot assume perfect candor in the process. In the spirit of Downs (1957), Festinger (1957), Berelson et al. (1954), Katz and Lazarsfeld (1955), and others, we expect the process to be contingent on the preferences and

[3] In this, as in earlier experiments, the value of the public information should not be overstated. The interval boundaries on candidate positions overlap significantly, and hence there is no guarantee that Candidate A lies to the left of Candidate B. In this way the election is more like a primary election within a party rather than a general election contest between parties.

expertise of informants, the range of available informants, and the potential for biased and misleading communication.[4]

HETEROGENEITY AND BIAS WITHIN NETWORKS

In the context of Downs' analysis, the experimental participants should select ***well-informed*** informants who ***share their preferences***. The problem for individual subjects is that the supply of such informants may be limited. Each of the directed graphs in Figure 9.1 illustrates one period (or election) within the experiment. The edges (arrows) point toward the individual from whom information is being requested. The size of the nodes reflects the amount of each individual's investment in private information, and it becomes clear that the more highly informed participants receive more requests for information.

At the same time, Figure 9.1 also shows that participants must often choose between (1) expert informants with preferences that diverge from their own and (2) non-experts with preferences similar to their own. While individuals might prefer to have expert informants who share their preferences, their choices are limited by availability in their local contexts, with important implications for network heterogeneity and the communication of bias. We begin the analysis by examining the first-order effects of our experimental manipulations on the creation of potential for heterogeneity and biased communication that is produced.

CRITERIA FOR SELECTING INFORMANTS

This problem is addressed more systematically in Part A of Table 9.1, where participant information requests are regressed on the amount of information each of the other participants requested, as well as the distance between the preferences within the relevant dyad – the preferences of both the potential recipient of information as well as the potential provider. The response variable equals one if the subject requested information from the dyad's alter in a given period, and equals zero otherwise. The table displays the results for all three social information requests, first pooling these requests, and then for each request individually. Thus, in models 2–4 of the table, each row in the data matrix is a dyad and model 1 pools these observations – hence, each row is at the dyad-request level. This structure means that each individual participant appears multiple times within the data set, and thus we apply a clustering correction on the standard errors of the coefficients (Williams 2000).

[4] Do participants understand the relatively more complicated process within which they are participating? While we do not debrief the participants after every session, we pre-tested all the experiments we conducted in this study to make sure that participants understood the procedures. Moreover, at the beginning of every session for every experiment we include a practice period for instructional purposes. Finally, we carefully monitor all the experiments, and it is clear that the participants understood the experimental process and procedures.

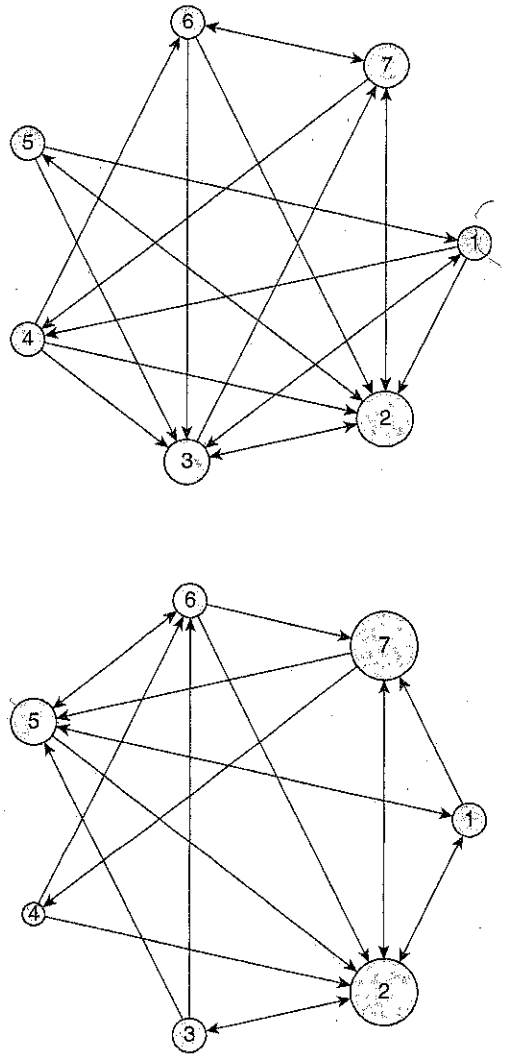

FIGURE 9.1. Directed graphs for typical periods in an experiment. Size of node indexes amount of information purchased. Direction of edge signifies the participant from whom information is being requested.

We do not restrict participants from making multiple information requests from the same participant during the same period. While it is a relatively rare event, Table 9.1 includes a control for whether the subject previously requested information from the potential discussant. Thus, in the second request for information, the indicator variable equals one if the subject's *first* request for information was to this potential discussant. In the third request, the indicator

TABLE 9.1. *Proximate effects of experimental manipulations.*
A. Creation of dyadic ties: information request by amount of information purchased by the potential informant and absolute distance separating preferences within the potential dyad. (Logit; standard errors corrected for clustering.)

	1. all choices		2. 1st choice		3. 2nd choice		4. 3rd choice	
	coef.	t-value	coef.	t-value	coef.	t-value	coef.	t-value
Preference distance[a]	−.14	3.56	−.12	2.50	−.17	3.49	−.13	2.34
Information purchased	.39	8.15	.58	8.58	.40	6.23	.24	4.12
Previous information request	−2.20	7.08			−2.20	5.49	−2.37	7.79
Constant	−1.82	14.83	−2.51	14.67	−1.74	11.20	−1.26	6.76
N=	13482 (84 subjects)		4494 (84 subjects)		4494 (84 subjects)		4494 (84 subjects)	
χ^2,df,p =	85, 3, .00		74, 2, .00		50, 3, .00		64, 3, .00	

B. Predicted probabilities of requesting information by distance separating preferences within dyad and informant information.

	1. ANY CHOICE		
	Minimum information	Maximum information	Δ
Minimal distance	.12	.40	.28
Maximal distance	.07	.26	.19
Δ	.05	.14	
	2. FIRST CHOICE		
	Minimum information	Maximum information	Δ
Minimal distance	.07	.42	.35
Maximal distance	.04	.28	.24
Δ	.03	.14	
	3. SECOND CHOICE		
	Minimum information	Maximum information	Δ
Minimal distance	.13	.42	.29
Maximal distance	.06	.24	.18
Δ	.07	.18	
	4. THIRD CHOICE		
	Minimum information	Maximum information	Δ
Minimal distance	.20	.39	.19
Maximal distance	.12	.25	.13
Δ	.08	.14	

C. Network centrality by information purchased and mean distance of preference from others in network. OLS regression w/ standard errors corrected for clustering.

	Coefficient	t-value	
Mean preference distance from others in network	−.25	1.49	
			N= 749 (84 subjects)
Private information purchased	.73	10.17	R^2=.29
			Root MSE= 1.39
Constant	2.33	5.00	

D. Estimated bias[b] of message by the absolute difference between the preferences of the sender and the receiver. OLS regression w/ standard errors corrected for clustering.

	Candidate A		Candidate B	
	Coefficient	t-value	Coefficient	t-value
Difference in preferences	.15	3.33	.15	2.93
Constant	.68	4.86	.73	3.90
N=	715 (76 subjects)		715 (76 subjects)	
R^2=	.02		.02	
Root MSE=	1.40		1.51	

[a] Preference differences in Parts A and D of the table are measured as the absolute value of the difference within the dyad.

[b] Bias is estimated as the absolute value of the distance between the message and the messenger's immediately preceding prior judgment regarding the candidates.

A one standard deviation increase in preference divergence .58 produces a reduction in the predicted number of information requests by .145, and an increase across its range (1.5) yields a reduction of .375. In contrast, a one standard deviation increase in the amount of information purchased yields an increase of .88 requests, and an increase across its range (4) yields an increase of 2.92 requests.

variable equals one if the subject's *first or second* request for information was to this potential discussant.

Each model demonstrates statistically discernible effects for the difference in preferences within the dyad, for the amount of information privately purchased by the potential recipient of an information request, and for previous information requests from a provider in the same period. Participants are more likely to request information from other individuals who (1) hold preferences similar to their own and (2) have made personal investments in privately acquired information. The control for repeated requests confirms that they are relatively rare, underlining the consequences of a constrained choice set on the supply of informants.

Based on the estimates in Part A of Table 9.1, Part B shows the corresponding changes in predicted probabilities of information requests across the

explanatory variables for respondents, with the dummy variable for previous information requests from a particular individual held constant at 0 or no previous request. The first model generates an effect for the information level of the potential informants that is substantially larger than the effect for preference, but it becomes clear that this first model is an average across the three requests for information that vary systematically across the exogeneous factors. The initial request is highly responsive to the potential informants' information levels, but this importance is increasingly attenuated for the second and third requests. In contrast, the importance of shared preferences on the part of the potential informants stays relatively constant across the three choices, but its effect never exceeds that of the informant's information level.

NETWORK CENTRALITY IN A CONTEXT OF LIMITED CHOICE

The problem is not that the criteria of choice are changing, but rather that the range of choices becomes increasingly limited. The context of the experimental group imposes limits on the ability to implement Downs' advice – participants are unable to locate sufficient numbers of experts with shared preferences. Network formation is thus subject to the constraints imposed by the particular configuration of the surrounding context (Huckfeldt and Sprague 1987). Within this context, perhaps one of the most surprising results of the chapter's analysis is that participants place a higher value on expert information, and hence they confront a heterogeneous stream of information.[5]

This result carries important implications for the structure of the communication network. In particular, it points toward experts as being particularly influential in the communication process, with high levels of network centrality. In Part C of Table 9.1, centrality is defined within a period (or election) as a subject's "indegree" – the number of requests for information received from other participants.[6] Participants with higher levels of indegree are more central to the communication of information within the process – the information they communicate occupies more space within the communication process. When this measure of indegree is regressed on the absolute distance between preferences within dyads and the amount of information that a potential informant has independently acquired, it becomes clear that expertise trumps shared preferences as the most important factor explaining centrality.[7]

[5] At the same time, it is important to recognize that the motivation to acquire information from an individual with shared preferences does not necessarily contradict the motivation to acquire information from an expert. One would have more confidence in the capacity of an expert with shared preferences to provide reliable information supporting those preferences.

[6] We report an OLS regression, but the substantive conclusions are unchanged when employing a negative binomial regression.

[7] A one standard deviation increase in preference divergence (.58) produces a reduction in the predicted number of information requests by .145, and an increase across its range (1.5) yields a reduction of .375. In contrast, a one standard deviation increase in the amount of information

IMPLICATIONS FOR BIAS

The fact that participants are more likely to weight expertise over shared preferences in the selection of an informant produces obvious advantages. At the same time, it also has the consequence of exposing recipients to messages from politically divergent sources – messages that are more likely to contain biases introduced by the informant. The participants in our experiment send messages aimed at persuading the recipient, and hence the messages are contingent on the sender's goals. Participants are free to send different messages to different recipients, and messages typically carry a bias that is distinctive to the position of the recipient relative to the sender. Hence, these messages are not unlike those frequently sent in ordinary political communication, where lively conversation is *both* informative *and* strategic.

Part D of Table 9.1 estimates bias in the messages sent by participants, where bias is defined as the distance between the message sent at the first opportunity for social communication during a period and the sender's immediately preceding prior judgment regarding the candidates. This measure of bias is regressed on the absolute distance separating the preferences of the sender and the receiver of the message.[8] The regression shows that bias increases as the distance between the preferences in the dyad increases. The maximum distance between preferences is six units, and hence the maximum predicted effect on a single candidate message is 90 percent of one unit (6 × .15). While these are relatively subtle effects, they are not without consequence, and even minimal levels of bias can be consequential when candidates converge. In short, the participants must take into account the potential for bias as well as the inherent noise that accompanies information taken from a stochastic distribution, and hence it becomes important to address the process through which network effects are realized.

INFORMATION, MEMORY DECAY, AND AUTOREGRESSIVE PROCESSES

Autoregressive models suggest that new information is judged relative to previously obtained information. Thus, new information that deviates from expectations based on past information would yield a diminished effect (Huckfeldt, Johnson, and Sprague 2004). We evaluate such a model in Table 9.2, which considers the subject's final summary judgment regarding a candidate's position as a function of (1) all three social messages, (2) the deviations of these social messages from the subject's judgments immediately prior to receiving the message, and (3) the interaction between the two. The models also include the

purchased (1.21) yields an increase of .88 requests, and an increase across its range (4) yields an increase of 2.92 requests.

[8] The number of observations in these models is lower than the previous estimates in Table 9.1 because they exclude the small number of subjects whose requests for information were denied.

TABLE 9.2. *Final judgments by priors and messages, with messages contingent on contemporaneous judgments.*

A. Candidate A	Coefficient	t-value	
Initial (prior) judgment	.16	2.38	
Prior X info. purchased	.10	4.08	N=749 (84 clusters)
Information purchased	−.35	3.75	R^2 = .58
First message deviation	.06	.71	Root MSE = .96
Second message deviation	.20	2.46	
Third message deviation	.50	6.38	
First message	.13	2.75	
Second message	.25	5.01	
Third message	.43	8.81	
First message X deviation	−.02	.92	
Second message X deviation	−.08	4.28	
Third message X deviation	−.13	6.65	
Constant	.18	.63	
B. Candidate B	**Coefficient**	**t-value**	
Initial (prior) judgment	.13	2.08	
Prior X info. purchased	.10	4.32	N=749 (84 clusters)
Information purchased	−.43	4.08	R^2 = .59
First message deviation	.12	1.53	Root MSE = .97
Second message deviation	.44	5.42	
Third message deviation	.54	4.93	
First message	.16	3.21	
Second message	.35	7.12	
Third message	.44	7.20	
First message X deviation	−.04	1.60	
Second message X deviation	−.10	4.70	
Third message X deviation	−.12	5.24	
Constant	.28	.81	

Initial (prior) judgment = the subject's initial judgment regarding candidate positions, based solely on the public information and any private information the subject purchased

Information purchased = the number of pieces of information the subject purchased at the beginning of the relevant period

Message deviation = the absolute deviation between the message the subject received from another subject at the current request for information, and the subject's most recent judgment regarding candidate position. (For the first message deviation, the most recent judgment is the prior. For the second and third deviations, the most recent judgments are the updates following the first and second messages, respectively.)

individuals' original prior judgments based on individually purchased private information, the amount of private information purchased, and the interaction between the prior and the amount of private information purchased.

This model provides support for an autoregressive influence model. In general, the ultimate effect of a message is attenuated by the absolute size of

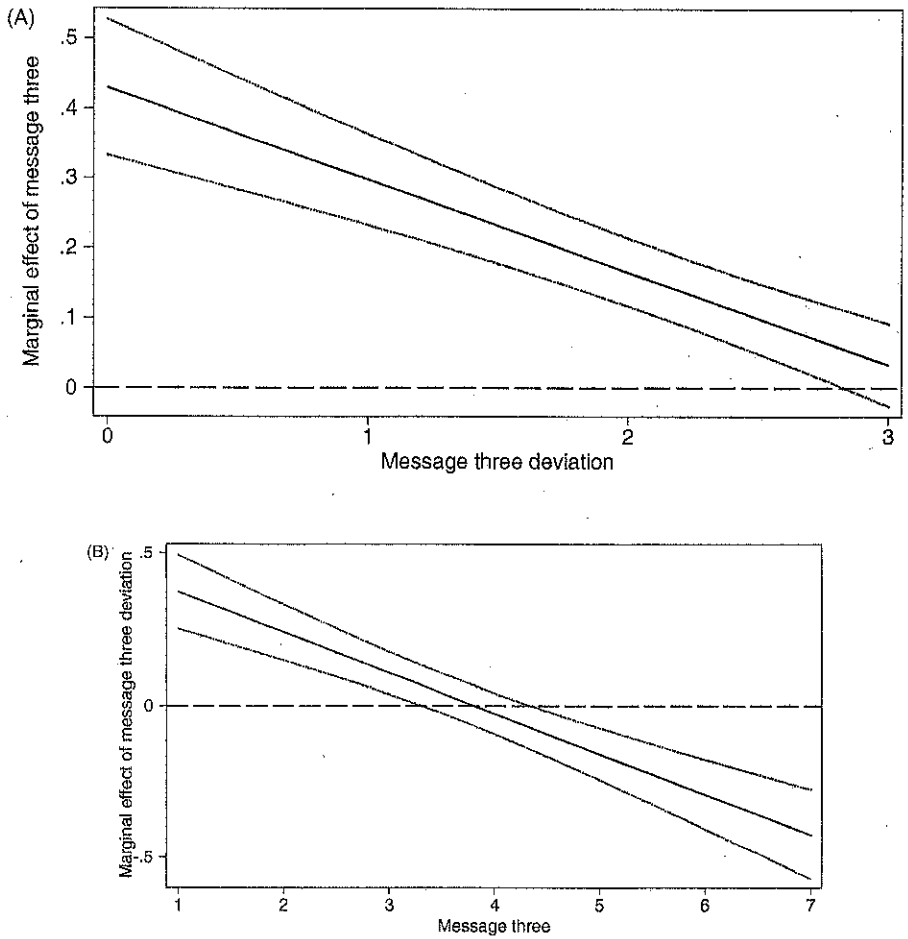

FIGURE 9.2. The autoregressive influence of social information.

A. Marginal effect (with 95% confidence bounds) of the third message on the subject's final judgment by the message's deviation from the subject's immediately prior update.

B. Marginal effect (with 95% confidence bounds) of the third message's deviation from the immediately prior update by the third message.

Data source: Estimates in Table 9.2a.

its deviation from the subject's immediately preceding, contemporaneous judgment regarding the candidates. The first message fails to generate a discernible pattern of effects for candidates, but this is due to a pronounced pattern of decay in the message's effects. More recent messages are consistently more influential because earlier messages tend to be forgotten (Lodge and Taber 2000).

Figure 9.2 graphically displays the autoregressive process for the subjects' final judgments of Candidate A. Part A of the figure demonstrates that the effect

of the third message on the subject's final judgment of the candidate diminishes as the message diverges from the subject's previous judgment. When the message is within one unit of the subject's previous judgment, the model predicts that the subject's next judgment will move about 0.3 units in the direction of the message. In other words, if the subject previously believed that the candidate was a 4 and the message suggests that the candidate is a 5, the model predicts that the subject's next judgment will be about 4.3. If the message is two units away from the previous judgment, its effect falls to about .2. Messages that deviate from the previous judgment by three units produce no discernible change on the final judgment. In other words, subjects dismiss such divergent information rather than integrating it into their judgments.

Part B of the figure displays the effect of a socially communicated message on the subject's final updated judgment when the message deviated from the subject's immediately prior update. That is, the figure illustrates the consequences of receiving a message that does not correspond to an individual's contemporaneous opinion. In particular, the figure focuses on the third social message and its deviation from the immediately preceding second update. When the message suggests that the candidate is on the far left (lower values), the effect of the deviation is positive. This positive effect counteracts the effect of the message, which would otherwise pull the subjects' final judgment downward. Conversely, when the message suggests that the candidate is on the right (higher values), the effect of a deviation is negative. Once again, this negative effect offsets the effect of the message, which would otherwise pull the subjects' judgments upward. Thus, the net influence of a message decreases with its deviation from subjects' immediately previous judgment.

In summary, this preliminary analysis shows three things. First, messages that are at variance with the subject's contemporaneous judgments at the time they receive the messages are less likely to be influential in affecting the subject's ultimate judgment. Thus, a subject's summary judgment is ***not*** based on a fresh look at all of the evidence. Rather, the final judgment depends on the subject's preliminary judgments and the contemporaneous judgment at the moment when a message is received (Lodge and Taber 2000). Second, and just as important, this analysis suggests a dynamic process in which more recent information is generally weighted more heavily than earlier information. Finally, it becomes clear that the experts – those individuals who invest more heavily in the acquisition of information – form prior judgments that are much more likely to endure through this influence process, as well as to register stronger effects on their summary judgments. Hence, we turn our attention to a simple model of the influence process to consider the consequences.

A SIMPLE MODEL OF THE PROCESS

We begin by expressing the updating process for the subjects' judgments as a function of three factors: (1) decay in the most recently updated judgment,

(2) decay in the initial (prior) judgment based on individually purchased private information, and (3) new incoming social information that is communicated by other subjects.

THE EFFECT OF THE PRIOR

The model assumes that the initial (or prior) judgment, formed on the basis of privately purchased information, has an enduring effect that declines at a compound fixed rate between judgments. At the first update, the effect of the prior is wP_o, where w is defined as (1–d, or 1 minus the single period rate of decay in the prior) and at the n^{th} update, its effect is thus w^nP_o.

THE EFFECT OF UPDATED JUDGMENTS

Updated judgments generate first-order effects that also decline at a fixed rate. At the n^{th} update, the effect of the previous update is αJ_{n-1}, where α is the survival of the previous judgment.

INCOMING INFORMATION

At the same time that the prior and the previously updated judgments are vulnerable to decay, the subject is responding to an ongoing stream of social information communicated by other subjects.

Hence, the current judgment arises as a consequence of the rate of decay in an immediately prior judgment update, the rate of decay in an initial prior judgment, and the effect of contemporaneous social information.

$$\Delta J_t = -dJ_{t-1} + w^tP_o + eI_t \qquad (9.1)$$

where $\Delta J_t = J_t - J_{t-1}$; d = the rate of decay in the previous judgment, with d expected to lie between zero and 1; P_o = the prior judgment based on privately purchased information; w^t = the effect of the prior at J_t, with w expected to lie between 0 and 1; I_t = incoming social information received at t; and e = the educative impact of the new social information.

The model is rewritten as:

$$J_t = \alpha J_{t-1} + w^tP_o + eI_t, \qquad (9.2)$$

where $\alpha = 1-d$ = the memory or survival of the previous judgment.

It is helpful to develop the model through recursion. At the first judgment (J_1) there is no previous judgment to update – only a prior based on private information plus new information, and thus

$$J_1 = wP_o + eI_1. \qquad (9.3)$$

Subsequent judgments update the immediately previous judgment as well as responding to the prior and new social information. Hence,

$$\begin{aligned} J_2 &= w^2P_o + eI_2 + \alpha J_1 \\ &= w^2P_o + eI_2 + \alpha wP_o + \alpha eI_1 \end{aligned} \qquad (9.4)$$

$$\begin{aligned} J_3 &= w^3P_o + eI_3 + \alpha J_2 \\ &= w^3P_o + eI_3 + \alpha w^2P_o + \alpha eI_2 + \alpha^2 wP_o + \alpha^2 eI_1. \end{aligned} \qquad (9.5)$$

Pushing the model beyond the reach of our experimental observations yields

$$\begin{aligned} J_n = {} & (w^nP_o + \alpha w^{n-1}P_o + \alpha^2 w^{n-2}P_o + \ldots + \alpha^{n-1}wP_o) \\ & + eI_n + \alpha eI_{n-1} + \ldots + \alpha^{n-1}eI_1. \end{aligned} \qquad (9.6)$$

To consider the long-term dynamic logic, we take the equation to its limit. For n sufficiently large, the equilibrium is

$$J_n = (w^nP_o - \alpha^n w^oP_o)/(1 - \alpha/w) + eI_n + \alpha eI_{n-1} + \ldots + \alpha^{n-1}eI_1. \qquad (9.7)$$

Assuming that both α and w are bounded by 0 and 1, the effect of the prior converges on zero and the summary judgments inevitably depend on the continuing stream of incoming information, where the stream of information is weighted to favor the most recent information.

In short, the past is attenuated because this system of behavior forgets past events and past judgments rather than accumulating them – as any stable system must. How fast does the memory of this behavioral system decay? The key lies in the behavior of w^n and α^n. As α increases – as the immediately past updated judgment looms larger in the formulation of the current judgment – the importance of information received earlier maintains its effect longer.

Since the updated judgment is the mechanism whereby the prior is modified by new information, α also provides an index on the temporal durability of effects due to messages from other participants. As w increases, the importance of the prior takes longer to disappear. In this context, it is important to consider the dynamic implications in the short-term as well as the long-term, and hence to obtain estimates for the model parameters.

ESTIMATING THE MODEL

For the purposes of estimation, we multiply both sides of Equation 9.4 by α before subtracting the corresponding sides of the equations from Equation 9.5. Upon rearrangement this yields,

$$J_3 = \alpha J_2 + w^3P_o + eI_3 \qquad (9.8)$$

Hence regressing the final updated judgment regarding a candidate's position on the previous judgment, the prior, and the incoming social information, provides statistical estimates for the model parameters – α, w, and e.

Part A of Table 9.3 displays the results of estimating the model in Equation 9.8. For both candidate judgments, the final updated judgment (J_3) is regressed on the immediately preceding updated judgment (J_2), the initial prior judgment (P_o), and the immediately preceding (third) piece of communicated information (I_3). In view of the demonstrated importance of private information consumption, the regressions also include the amount of information purchased as an explanatory variable, as well as its interaction with both the third installment of communicated information and the prior judgment.

First, the table shows that the initial (prior) judgment has no effect in the absence of the interaction with the amount of information purchased. That is, the prior matters only among those participants who invest in private information, and the effect is enhanced by the level of that investment. Second, as would be expected, the table shows a substantial effect due to the immediately preceding update. Third, the model shows a substantial effect due to the final (third) message that appears to be at least modestly attenuated by the amount of private information purchased by the participant.

Part B of Table 9.3 adds an interaction between the third message and its deviation from the subject's immediately preceding (third) updated judgment. This yields no change in the estimates from Part A of the table, and it fails to produce a discernible effect due to message deviation. Hence, we pursue the analysis based on the results in Part A. In view of the results shown in Table 9.2, the lack of an interaction effect due to the deviation between the message and its distance from the subject's immediately previous update warrants explanation. The difference is that the models in Parts A and B of Table 9.3 include updated judgments as regressors, while the models in Table 9.2 only include the prior, the stream of incoming messages, and the interaction with the divergence of these messages from participants' immediately preceding updates. These results thereby support the on-line processing model of Lodge et al. (1995) – the memory of past information is mediated by past judgments. The information is not recalled directly and has no lasting effect, except as it forces updates in judgment.

Part C of Table 9.3 shows the estimated model parameters adjusted for the amount of information purchased by the subject. The results show that the survival of the prior is directly related to the amount of information purchased. Indeed, apart from the interaction of the prior with the amount of information purchased, the prior has no effect. (This result means that we cannot reject the null hypothesis that *w* is 0 for the subjects who purchased no information.) In contrast, however, there is a dramatic effect of information investments on the survival of the prior. If we fail to reject the null that there is no effect among those who did not purchase information, *w* varies from 0 to .64 for the judgment regarding Candidate A.

TABLE 9.3. *Estimating the dynamic model of judgment formation.*
A. Final updated judgment by initial (prior) judgment, previous update, and final communicated information, with interactions.

	Candidate A		Candidate B	
	Coefficient	t-value	Coefficient	t-value
Initial (prior) judgment	.004	.09	.04	.97
Immediately previous (third) update	.66	11.81	.63	10.17
Third message	.21	4.88	.21	3.55
Prior X info. purchased	.06	2.82	.07	3.29
Third message X info. purchased	−.03	−2.28	−.04	1.64
Information purchased	−.08	.93	−.16	1.57
Constant	.36	1.62	.53	1.80
N =	749 (84 clusters)		749 (84 clusters)	
R^2 =	.69		.70	
Root MSE =	.81		.83	

B. Final updated judgment by initial (prior) judgment, previous update, and final communicated information, with interactions.

	Candidate A		Candidate B	
	Coefficient	t-value	Coefficient	t-value
Initial (prior) judgment	.007	.14	.04	.95
Immediately previous (third) update	.65	10.23	.63	9.60
Third message	.25	4.19	.21	3.52
Prior X info. purchased	.06	2.74	.07	3.27
Third message X info. purchased	−.03	2.22	−.03	1.54
Information purchased	−.08	.87	−.16	1.63
Third message deviation	.04	.48	.03	.33
Third message deviation X message	−.02	.97	−.002	.09
Constant	.36	1.41	.47	1.95
N =	749 (84 clusters)		749 (84 clusters)	
R^2 =	.70		.70	
Root MSE =	.81		.83	

C. Model parameters adjusted for individual information purchases, based on the estimates from Part A.

	Candidate A					Candidate B				
	Amount of information purchased					Amount of information purchased				
	0	1	2	3	4	0	1	2	3	4
W	.16	.40	.51	.58	.64	.35	.49	.57	.64	.69
α	.66	.66	.66	.66	.66	.63	.63	.63	.63	.63
e	.21	.17	.14	.10	.06	.21	.17	.14	.10	.06

The effect of socially communicated information is also dependent on information purchases. Those who did not purchase any private information show an effect that is more than three times larger than the effect among those who purchased four pieces of information on each of the candidates. In short, those who purchase private information do not pay much attention to socially communicated information, and those who do not purchase private information are reliant on socially communicated information obtained from other subjects.

What are the dynamic implications? Part A of Figure 9.3 shows the decay in the prior over time for judgments regarding Candidate A. The figure plots the influence of the prior at the time the prior is given (J_0) through the final judgment (J_3) for individuals purchasing four, two, and zero pieces of information. In general, we see quite rapid decay in the effect of the prior, even among those individuals who purchased the maximum of amount of private information.

In contrast, Part B of the figure shows the decay in the effect of socially communicated messages from the first judgment subsequent to their reception (J_1) through the final judgment (J_3). In this instance the decay occurs relatively more slowly, but, in contrast to the effects of the prior, we see the greater effect of communicated messages on those subjects who purchased less private information. That is, among those who purchased four pieces of private information, their fourth and final judgment relies on approximately 40 percent of the prior, but is virtually independent of the first social message. In contrast, among those who purchased no information, the contribution of the prior has disappeared, and we see a modest effect due to the first social message.

The implications are quite important. While experts play a central role in the process of political communication, we should not view them as wholly independent actors who emit signals but do not receive them. While experts are able to assess incoming signals in the context of their own accumulated knowledge, their judgments based on this knowledge decay with time, and this process of decay is offset by new, socially communicated information. As Katz (1957) informed us more than fifty years ago, politically expert citizens are not immune to the effects of social communication.

Is the process autoregressive? The results show an interplay between recency and primacy in the communication process. Everything else being equal, recent communications matter more than earlier communications, and the decay of earlier communications enhances the relative effect of the most recent communications. At the same time, decay is mediated by expertise. Individuals who invest more heavily in the acquisition of private information demonstrate a more enduring effect due to their priors, at the same time that they rely less heavily on messages obtained from others. As a consequence, they engage in on-line processing (Lodge and Taber 2000), where new information is judged and assessed in the context of pre-existing judgments, and thus they tend to be more intransigent in their opinions.

In contrast, those who do not invest in private information rely less heavily on their prior judgments, and they pay more attention to new messages and new information. Hence, the updating process takes on relatively more importance.

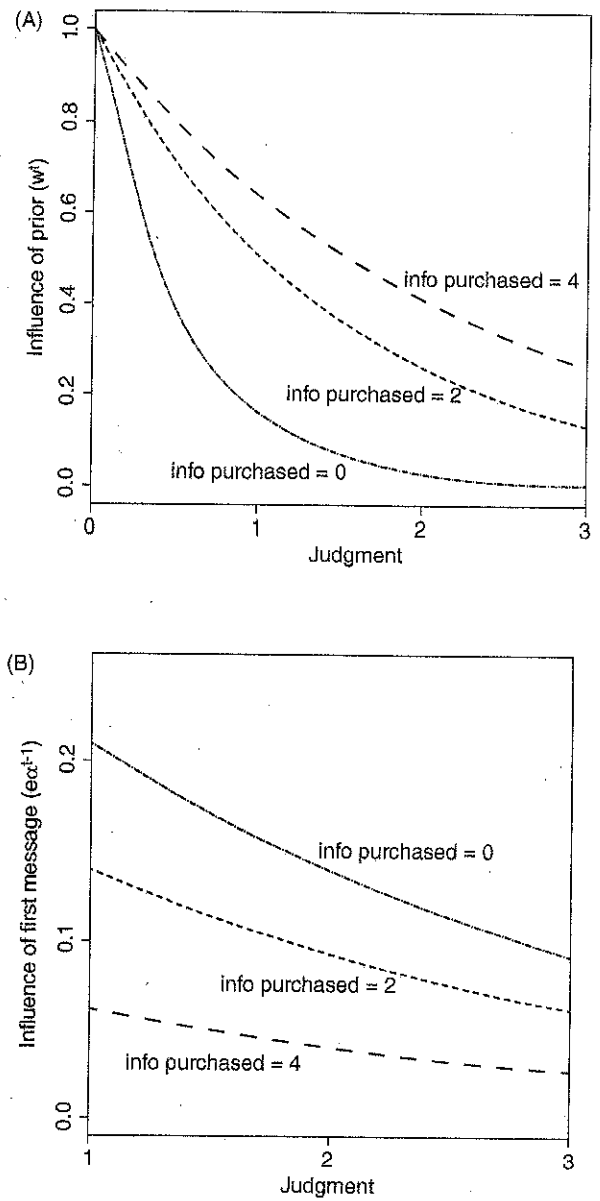

FIGURE 9.3. Implications of the model.
A. Temporal decay in influence of prior (w^t).
B. Temporal decay in influence of social messages ($e\alpha^{t-1}$).
Data source: Estimates in Table 9.3a.

The process is still autoregressive – informationally impoverished individuals do not exercise a comprehensive, memory-based processing strategy. It is simply the case that, lacking a strong prior on which to formulate a judgment, they necessarily rely more heavily on contemporaneous information.

HETEROGENEOUS INFORMATION AND THE VOTE

Individuals are thus faced with a heterogeneous stream of incoming information and limits on their ability and willingness to make continuing investments in additional information.[9] Their votes become the culminating events in a dynamic process where people sift and weigh the information they obtain by their own efforts, as well as the information they receive from others. In this context, we consider the participant's vote choice as a function of the entire process, in the context of their priors, their updates, and the final information purchase. How do individuals aggregate this heterogeneous stream of information in order to arrive at a binary vote decision?

We define a vote propensity measure that is defined in terms of the logit (L), or the log of the odds ratio, and the probability of voting for Candidate B is defined as:

$$P = 1/\left(1 + e^{(-L)}\right), \tag{9.9}$$

The propensity measure is defined as a linear function of the subjects' accumulated experience – privately purchased information, socially communicated information, and their own judgments and relative assessments of the candidates. The assessments constitute a combined response to both candidates, based on the perceived distance between each of the candidates and the position of the particular subject.

A_t = the relative assessments of the candidates at time t

$$= |J_{at} - \text{ideal}| - |J_{bt} - \text{ideal}| \tag{9.10}$$

Where J_{at} is the individual's judgment regarding the position of Candidate A at time t, J_{bt} is the judgment regarding Candidate B at time t, and "ideal" is the individual's ideal – their own position on the seven-point scale. The range of the resulting measure is from −6, for the most positive relative assessment of Candidate A, to 6 for the most positive relative assessment of Candidate B.

One might thus conceive the propensity as a consequence of all the privately purchased and socially communicated information an individual has obtained, as well as each of their four preliminary judgments regarding each candidate. Alternatively, the same logic that produced Equation 9.8 also generates:

[9] Analyses not shown here suggest that participants who obtained more heterogeneous information, as well as participants with more heterogeneous priors and updated judgments, are no more likely to purchase information at the final opportunity, immediately prior to the vote. In short, investing in additional information does not seem to be a commonly adopted solution to noisy information streams.

$$L = f(A_3, A_o, eI_4, dD_4) \tag{9.11}$$

where:

A_o = the individuals' initial or prior assessments of the two candidates, based on their initial judgments of the candidates' position relative to their own positions

A_3 = the individuals' final updated assessments of the two candidates, based on their final judgments of the candidates' positions relative to their ideals

D_4 = 1 for subjects who purchased information at the last opportunity; 0 otherwise

I_4 (for individuals who did not purchase information at final opportunity) = 0

I_4 (for individuals who purchased information at final opportunity) = $|I_{a4} - \text{ideal}| - |I_{b4} - \text{ideal}|$

I_{a4} = information regarding the position of Candidate A at the final opportunity (t=4)

I_{b4} = information regarding the position of Candidate B at the final opportunity (t=4)

ideal= the participant's fixed ideal position

While the non-linearity of the logit model precludes the direct estimation of the decay rates (w and α), we can still evaluate the relative importance of the priors through time and across levels of investment in private information.

The model is estimated in Table 9.4, where the prior assessment, the final assessment, and the final information purchase are also included in interaction variables with the amount of information purchased by the subject at the first opportunity. The estimates show that both the prior assessment and the final assessment are contingent on the initial acquisition of information. The final judgment has an independent effect that is further enhanced by the initial information purchase. The prior has an effect that is wholly contingent on the initial information purchase, and indeed the prior has no effect among those participants who did not purchase information. Finally, the final information purchase has no effect, either independently or contingently.

The magnitudes of the effects estimated in Table 9.4 on the probability of voting for Candidate B are shown in Table 9.5, where each part of the table corresponds to a different level of investment in privately purchased information at the outset of an experimental round. And it comes as no surprise that, in all three parts of the table, we see a much more pronounced effect of the final candidate assessments in comparison to the prior assessments. If the final assessment is unambiguous – if the subject's judgments regarding the candidates lead to *a clear and certain preference* – the prior appears to be largely irrelevant.

In contrast, we see a pronounced effect of the prior when either of two circumstances are present: (1) when the subject's final candidate assessment

TABLE 9.4. *Candidate vote by prior assessment, final assessment, and information purchased at the last opportunity, contingent on amount of initial information purchase. Standard errors are corrected for clustered observations on subjects.*

	Coefficient	t-value
Prior assessment (A_0)	−.12	−1.18
Final assessment (A_3)	.35	2.62
Final formation purchase (I_4)	.29	0.63
Prior assessment X amount of initial information purchase	.13	2.13
Final assessment X initial information purchase	.21	3.15
Final information X amount of initial information purchase	.07	0.42
Amount of initial information purchase	.12	1.50
Last information purchase (D_4)	−.03	−0.12
Constant	−.19	−1.17

N = 749 (84 subjects)
χ^2, df, p = 112, 8, .00

prior to voting is ambiguous, thereby creating a *higher level of uncertainty* (Tversky and Kahneman 1974), and (2) when the subject invested more resources in the purchase of information at the beginning of the round. If either of these conditions is absent, the importance of the prior judgments is greatly reduced. In this context, it is important to emphasize that, on average, the candidates tend to lie close together on the seven-point scale. Nearly 80 percent of the candidate pairs lie within 3 points of each other on the scale, and the mean distance is 2.4. Hence, a great deal of the activity involves close calls, where both actual and perceived best choices are ambiguous and uncertain. This means, in turn, that the priors are highly relevant in most circumstances, but only when subjects have invested heavily in privately acquired information. In ambiguous decision-making settings, the highly informed experts make up their minds early, and they are highly unlikely to change their minds (Lodge and Taber 2000).

The survival of the prior judgment is shown in Figure 9.4 as a function of the certainty of the final judgment and individual information purchases. The figure clearly demonstrates the dramatic and contingent effects of both final judgment certainty as well as expertise on the survival of the prior's influence.[10] This analysis provides a formidable test of the autoregressive argument. One might expect that earlier judgments would be subsumed in subsequent judgments. This analysis reveals, however, that past judgments take on lives of their own.

[10] The certainty of the final judgment is defined as the absolute value of the candidate propensity reflected in the final judgment, and hence it varies from 0 to 6.

TABLE 9.5. *Predicted probabilities of voting for Candidate B by candidate propensities of prior and final judgments.*
A. Participants who purchased four pieces of information.

Candidate propensity of final judgment	Candidate propensity of prior judgment							
	−6	−4	−2	0	2	4	6	Δ
−6	0	0	0	0	0	.01	.02	.02
−4	0	0	0	.01	.02	.06	.16	.16
−2	0	.01	.03	.08	.21	.43	.68	.68
0	.04	.11	.26	.50	.74	.89	.96	.92
2	.32	.57	.79	.92	.97	.99	1	.67
4	.84	.94	.97	.99	1	1	1	.16
6	.98	.99	1	1	1	1	1	.02
Δ	.98	.99	1	1	1	.99	.98	

B. Participants who purchased two pieces of information.

Candidate propensity of final judgment	Candidate propensity of prior judgment							
	−6	−4	−2	0	2	4	6	Δ
−6	0	0	.01	.01	.02	.03	.04	.04
−4	.01	.02	.03	.04	.07	.12	.18	.17
−2	.04	.07	.11	.18	.27	.38	.50	.46
0	.17	.26	.37	.50	.63	.74	.83	.66
2	.50	.62	.73	.82	.89	.93	.96	.46
4	.82	.88	.93	.96	.97	.98	.99	.17
6	.96	.97	.98	.99	.99	1	1	.04
Δ	.96	.97	.97	.98	.97	.97	.96	

C. Participants who purchased no information.

Candidate propensity of final judgment	Candidate propensity of prior judgment							
	−6	−4	−2	0	2	4	6	Δ
−6	.11	.11	.11	.11	.11	.11	.11	0
−4	.20	.20	.20	.20	.20	.20	.20	0
−2	.33	.33	.33	.33	.33	.33	.33	0
0	.50	.50	.50	.50	.50	.50	.50	0
2	.67	.67	.67	.67	.67	.67	.67	0
4	.80	.80	.80	.80	.80	.80	.80	0
6	.89	.89	.89	.89	.89	.89	.89	0
Δ	.78	.78	.78	.78	.78	.78	.78	

Data source: Estimates in Table 9.4.

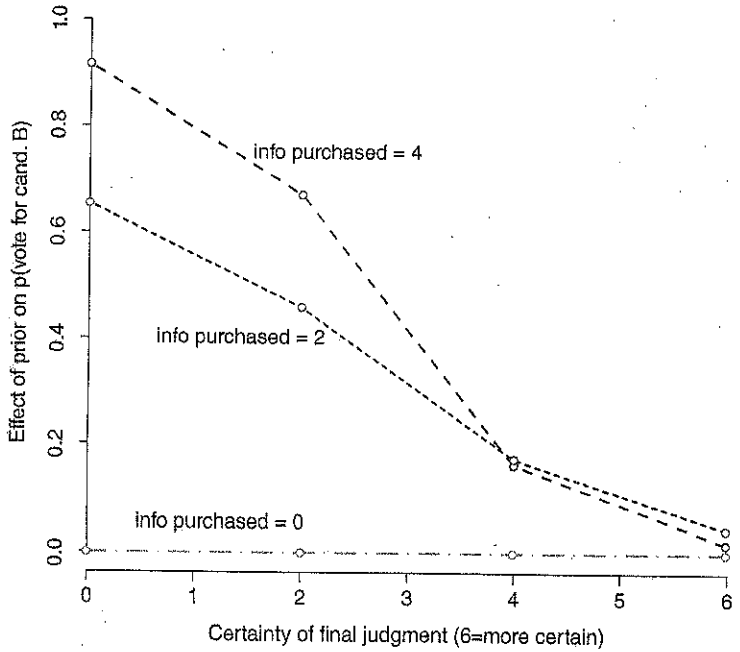

FIGURE 9.4. The effect of prior judgment on the probability of voting for Candidate B as a function of the certainty of the final judgment.
Data source: Estimates in Table 9.5. Certainty is measured as the absolute distance between the subject's final pre-vote assessments of the two candidates.

Particularly in ambiguous, uncertain decision-making environments, the memory of past judgments affects contemporaneous behavior among the high-volume consumers of information, even when contemporaneous judgments are taken into account.

IMPLICATIONS AND CONCLUSIONS

Political information is both noisy and biased, as a direct and inevitable consequence of its subject matter. For many people in many circumstances, political issues are complex and ambiguous, with frequently high levels of uncertainty. At the same time, many other individuals are deeply invested in particular opinions and attitudes and hence care very deeply about political issues and outcomes. Communication regarding politics thus reflects both the complexity of the subject matter and the existence of strongly held opinions. Moreover, the attentive are being continually bombarded by heterogeneous streams of information that are both biased and difficult to validate.

In this context, citizen experts play an important role, even if most experts are self-appointed. In the context of citizen politics, the experts are those activists

who care enough about politics to pay the costs of becoming informed. For many, the costs are not so terribly high for the simple reason that they thrive on the acquisition and analysis of political information. Whether the favored information source is the *New York Times*, *The Daily Show*, Fox News, or Rush Limbaugh, the expert is often ready and willing to pay the costs of becoming informed. Or, alternatively, the experts encounter no costs because they enjoy the process of becoming informed. Who are these people who realize no costs? They are likely to be the activists who thrive on, and are motivated by, their fascination with the world of politics.

The citizen experts are important for several reasons. They fill the social airwaves with political content. They package the information they transmit within inevitable patterns of bias that reflect their own interests and concerns. They provide an information source for those political non-junkies who would just as soon spend their time in the pursuit of other interests and avocations. Most importantly, they inject political content into the everyday patterns of communication and interdependence that exist among citizens in democratic societies.

In some ways, political experts display high levels of political self-reliance. Through their private investments in political information, they develop their own political priors regarding a vast array of issues and problems. At the same time, this analysis also suggests that the independence and self-reliance of experts can be overstated. Knowledge and information are indeed fleeting, if only due to the inevitable processes of decay that undermine the certainty of almost any judgment. Hence, political junkies sustain their positions as experts, not by the breadth of their knowledge regarding things political, but rather by their continuing pursuit of political information. Their energy in the pursuit of politics gives rise to the continual formulation of new prior judgments regarding a great variety of issues and problems.

Moreover, this chapter's analysis suggests that even experts are affected by patterns of communication with others, and sometimes these others may be less politically expert. Indeed, a defining ingredient of the expert is a willingness to engage in political communication with others, and our results show that this communication is not without consequence. Hence, the influence of political communication may sneak in through the back door, integrating the expert within patterns of communication that rebound as a source of influence on the prime mover.

Finally, the analysis suggests that the process of becoming informed is autoregressive – individuals encounter and digest new information in the context of old information. This autoregressive process is best understood as an on-line process among the politically expert because these are the individuals with well-developed attitudes, opinions, and beliefs. As we have seen, strongly held opinions survive the process of on-line updating, and hence the experts tend to be only modestly affected by new information. In contrast, the judgments formed by the less expert are not anchored in strongly held priors, and hence they are much more susceptible to messages received from others.

A question that naturally arises is whether the social communication process we have specified resembles a Bayesian updating process – that is, are the subjects in our experiment employing Bayesian reasoning when they formulate prior judgments based on private investments in information and then update those judgments based on information that is socially communicated? If the process is Bayesian, the updated judgment should represent both the prior and the newly acquired information, where both are weighted inversely by their respective variances (Bullock 2009; Bartels 2002; Gerber and Green 1999). Such an account runs at least partially parallel to the social communication process analyzed here. Individuals form final judgments based on priors weighted by the amount of unbiased information they use in formulating the prior. This weight is an entirely reasonable (inverse) function of the variance around the prior, where a higher level of information consumption thus indexes a reduced level of variance. Moreover, the analysis suggests that participants are cautious regarding the value of new information. They seek to minimize misleading bias by locating informants whose interests coincide with their own, and they are skeptical regarding new information, particularly information taken from non-experts whose judgments they do not trust.

The comparison to a Bayesian process thus provides an interesting frame of reference for evaluating the implications of social influence in politics. While there is certainly no evidence to suggest that the participants in our experiment are self-consciously invoking Bayes' theorem, they appear to be invoking standards of judgment that approximate a Bayesian process. Alternatively, this social communication process might also be understood in terms of motivated reasoning. After investing more heavily in the formulation of their own prior judgments, the experts among our participants are personally committed to these judgments and less likely to be swayed by information to the contrary (Kunda 1999; Lodge and Taber 2000). Thus, in several different ways, a social influence process might ironically result that, quite apart from any intent on the part of the participants, parallels Bayesian updating.

The implication is that, in terms of May's (1976) observation with which we began this chapter, we are indeed observing patterns of behavior marked by pronounced levels of non-linear interdependence. Not only does current behavior depend on past behavior, but it also depends on the behavior of others within the context where the individual is located. Some of these individuals – those with strong commitments to their own prior beliefs – are relatively less susceptible. For those without strongly held priors, their behavior is highly dependent on the behavior of others, and the implications for political dynamics are quite profound (Huckfeldt 1990).

This analysis is extended in Chapter 10, with a focus on higher-order dynamic implications. Communication networks generate a sequential dynamic process that is inherently endogenous with important higher-order consequences. Mort talks to Harvey; Harvey talks to Ted; Ted talks to Doris; Doris talks to Harvey; and Harvey talks to Mort. The system is inherently dynamic, and Mort's influence stops with neither Harvey nor Ted, but percolates through the system of relationships, ultimately coming back to register a potential effect on its originator. We address these issues in the context of memory decay and the role of well-informed, durable priors in opinion leadership.

CHAPTER 9 APPENDIX

INSTRUCTIONS TO PARTICIPANTS

The following instructions were read to all subjects before the experiment began. These instructions reference screens that can be viewed at johnbarryryan.com.

Thank you for participating in today's experiment. I will be reading from a script to ensure that every session of this experiment receives the same instruction. Feel free to ask questions if you require clarification. This instruction explains the nature of today's experiment as well as how to navigate the computer interface you will be working with. We ask that you please refrain from talking or looking at the monitors of other participants during the experiment. If you have a question or problem please raise your hand and one of us will come to you.

Please turn to your informational handout while I read from it.

Instructions for the experiment

This experiment is about information and voting, and it takes place over approximately ten rounds.

During each round, you will consider two candidates.

Your goal is to elect the candidate at each round whose position is closest to your own position.

Each participant in the group receives 100 ECUs at the beginning of each round. Participants earn an additional 50 ECUs if the candidate whose position is closest to their own position wins the election for that round. And they lose 50 ECUs if the candidate closest to their position loses the election for that round. If there is a tie, nobody earns nor loses ECUs. Participants also spend ECUs by purchasing information during each round.

Each ECU is worth 1 cent. So, over ten rounds you will receive a total of 10 dollars as your endowment.

Your total earnings will grow when the candidate closest to you wins, and decrease when the candidate closest to you loses. You will also have the opportunity to spend your ECUs on additional information about the candidates.

Your total payout will be: $5 for being willing to participate, plus your earnings.

Positions of candidates and participants

Your position and the candidates' positions are represented on a scale that varies from 1 to 7. You will be assigned a precise position on the scale, and hence you will know your own position exactly, as well as the positions of the other participants.

The candidate's position will be more difficult to determine. Candidate A's position lies somewhere between 1 and 6. Candidate B's position lies somewhere between 2 and 7.

Your position is fixed throughout this session. The candidates' true positions change between rounds. This means that the candidate closest to your position at one round may not be closest to your position at the next round.

Information

You will have two different types of information to use in estimating the candidates' positions:

1. ***Information about the candidates that you purchase with** ECUs. You can purchase information regarding the candidates. The problem is that, while this information is accurate on average, any single piece of information is likely to diverge from the candidate's true position.*
2. ***Information about the candidates obtained from others.** You will also have the opportunity to obtain information from other members who are participating with you. In making this request, you will know each participant's exact position, as well as the amount of information each participant has purchased. All information obtained from others is free, but the information that the participant provides may or may not reflect that participant's true beliefs regarding the candidate's position.*

Now, please turn to your computer screens. We have prepared several demonstration screens to help you get familiar with the actual screens you will see during the experiment.

(SCREEN ONE) This is the first screen you will see in each period. The top of each screen displays the period and the time remaining for this screen. We suggest that you make your decisions for a screen within the time limit, but you will not be forced to make decisions in that time.

In the upper left hand corner, you will see your participant number and your position. This information will be in the upper left hand corner on every screen.

On this screen, you will be allowed to purchase private information about the candidates. Information costs a certain amount of money. You may purchase up to four pieces of information, so long as you spend less than with 50 ECUs. You may also purchase no private information. For this practice round, please purchase at least one piece of private information. Please purchase some information and click "OK."

(SCREEN TWO) This screen displays the private pieces of information that you bought. On average, private information accurately represents the candidates' true position, but any single piece of information could be inaccurate.

Each piece of information is a number randomly drawn from an interval centered on the candidate's true position and extending 3 positions above and below that true position. So, while the candidate's proposals are bound between 1 and 7, the information you receive could fall outside of those bounds.

Based on the information you see, you are asked to estimate the candidate's positions. Enter estimates for the two candidates and click OK.

(SCREEN THREE) You are also able to request information from other participants. You are accurately told the other participants' number and position as well as the amount of private information the other participant received on the previous screen. There is no cost for requesting this social information. Please enter the participant number from the player you wish to request social information from and click OK.

(SCREEN FOUR) On this screen, you provide social information to participants that requested social information from you. You are accurately told the other participants' number and position, as well as the amount of private information the participant has purchased. You do not need to provide information to the other participants, nor do you need to provide identical information to each of the participants who asked information from you. You are reminded of the positions that you thought the candidates held after receiving the private information. Enter the information about the candidates that you want to provide to the other participants and then click OK. If no one requested information from you, simply click OK.

(SCREEN FIVE) On this screen, you receive information from the participant you requested information from. You are accurately told the other participants' number and party as well as the amount of private information the other participant received on the first screen. You are also given the participant's stated estimate of the candidates' position.

Once again, you are asked to estimate the candidate's benefit. You are reminded of your previous estimate. Enter estimates for the two candidates and click OK.

(SCREENS SIX/SEVEN/EIGHT/NINE/TEN/ELEVEN) You will request and provide information two more times from and to other participants. Each time you request information, you will be reminded of the participants you have previously requested information from. Enter the next candidate that you would like to request information from and click OK.

(SCREEN TWELVE) On this screen, you will have the opportunity to purchase a final piece of private information for 10 ECUs. Choose whether you would like to purchase an additional piece of information and click OK.

(SCREEN THIRTEEN) Once again, you are reminded of your previous estimate. If you purchased another piece of private information, it will show up on this screen. Now, it is time to vote. You should vote for the candidate that you think will be closer to your issue position. Your final cash payoff is calculated by adding what is left of your initial endowment to the 50 ECU bonus you receive from the candidate closer to your issue position winning or subtracting the 50 ECU penalty you receive from the other candidate winning. For example, if you had 80 ECUs left from your initial endowment after purchasing private information, and your ideal candidate won, you would end the round with 130 ECUs (80 plus 50). If the other, less ideal, candidate won, you would end the round with 30 ECUs (80 minus 50).

Vote for one of the two candidates and click OK.

(SCREEN FOURTEEN) This is the final screen. The two candidates' positions are revealed as is the outcome of the election. You will also learn the number of ECUs you earned in this period as well as the number of ECUs you have earned up to this point in the experiment.

The experiment will consist of 10 periods like this one. At the end of these 10 periods, you will be asked a couple of questions about the experiment, asked to provide some demographic information, and a couple of questions about your general political leanings. All of your responses are anonymous.

This concludes the demonstration screens. We are now ready to begin the actual experiment. We ask that you follow the rules of the experiment. Anyone who violates the rules may be asked to leave the experiment with only the $5 show up fee. Are there any questions before we start?

10

The complex dynamics of political communication

Robert Huckfeldt, Matthew T. Pietryka, and Jack Reilly

> Each ant lives in its own little world, responding to the other ants in its immediate environment and responding to signals of which it does not know the origin. Why the system works as it does, and as effectively as it does, is a dynamic problem of social and genetic evolution.
>
> Thomas Schelling (1978: 21)

Particularly in the context of complex political processes involving hundreds or thousands or millions of citizens, the whole is typically an unintentional byproduct viewed from the vantage point of the participant. Just as the formation of political beliefs and opinions is not solely due to a cognitive process occurring between the ears of isolated individuals, so too the implications of political communication among citizens is not solely due to an isolated process occurring within self-contained dyads. Not only do the beliefs of individuals depend on what happens within dyads, but the effects of single dyads are contingent on the other dyads within which individuals are simultaneously located (Huckfeldt, Johnson, and Sprague 2004). Moreover, these network effects are not simply cumulative across an individual's range of contacts. To the contrary, the effects are sequential, dynamic, and interdependent. While voters certainly do not resemble Schelling's ants, public opinion in the aggregate is created through complex processes of interaction and communication, located in both space and time, which are at least as complex as those producing the anthill.

This chapter takes a modest step toward understanding an important micro–macro problem in democratic politics (Eulau 1998). In particular, our concern is whether individual levels of political expertise serve to inform the aggregate through the patterns of communication existing among interdependent individuals. We address this problem by extending the analysis of the small group experiments in Chapter 9 to address the consequences of dynamic interdependence for aggregate rather than individual outcomes.