Intrinsic Dynamics of Social Judgment

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Social judgment is a broad category, encompassing such distinct phenomena as causal attribution, impression formation, prejudice, and moral evaluation (cf. Eiser, 1990; Fiske & Taylor, 1991; Zebrowitz, 1990). Although each of these judgmental phenomena is associated with its own purported cognitive and emotional processes, collectively they share a critical assumption concerning stability and the basis for change in the output of their respective processes. The assumption is that once a judgment is formed, it is stable unless it is updated by new information or challenged by social influence. By implication, if a person experienced neither pressure nor new information, and if measurement error could be eliminated by directly accessing the contents of the person’s mind, the person’s summary judgment concerning a target would stand still and could be characterized as a single point on an appropriately labeled scale. Our aim in this article is to provide support for a different perspective on the nature of stability and change in social judgment. In particular, we suggest that under some conditions the output of social judgment is inherently dynamic rather than stable. The dynamics of judgment, moreover, are generated by internal mechanisms—specifically, the interaction of elements in the judgment system—and thus can occur in the absence of external forces (new information or social influence). In this respect, the social judgment system can be said to display intrinsic dynamics like those observed in dynamical systems in physics and biology (cf. Schuster, 1984). Temporal variation in judgment should therefore not be dismissed as random noise but rather should be recognized as conveying meaningful information about the judgment per se and, more important, about the structural properties of the underlying system. As such, social judgment cannot always be adequately characterized by traditional measures that emphasize the central tendency of the judgment over time. Rather, when judgment displays intrinsic dynamics, the output of the judgment system is best characterized by variables that describe properties associated with patterns of change. This perspective requires an empirical approach that explicitly tracks the trajectory of judgments over time. We propose such an approach—the mouse paradigm—and demonstrate its viability for capturing the intrinsic dynamics of social judgment.

Theoretical Rationale

Evaluation is commonly considered the most important aspect of social judgment (cf. Anderson, 1981; Wegner & Vallacher, 1977). A target of judgment can be considered with respect to a variety of specific cognitive elements, of course, but each of these elements has a projection on an evaluative dimension (cf. Anderson, 1981; Kim & Rosenberg, 1980). These projections, in turn, tend to be combined in some fashion to promote an overall evaluation of the target, although there is disagreement concerning the specific combinatorial function involved (cf. Eiser, 1990; Fiske & Taylor, 1991). The single variable of evaluation thus provides a global description of the state of the system. Evaluation, then, may be regarded as an order parameter for social judgment in the same sense that order parameters are derived and used to characterize the global state or behavior of multi-element systems in other areas of science (cf. Landau & Lifschitz, 1968).

The issue of stability versus change in social judgment can thus be reframed in terms of the factors that promote stability...
versus change in evaluation. Sometimes an evaluation of a target is stored in memory independently of the facts, behaviors, and other cognitive elements that generated it (e.g., Dreben, Fiske, & Hastie, 1979). In such instances, it is reasonable to expect evaluation to be stable over time, unless it is regenerated on the basis of new information or changed in response to social pressure. At other times, though, the output of social judgment is directly linked to cognitive elements stored in memory. Such linkage is observed when subjects are asked to think about a particular target in the absence of new information (Chaiken & Stangor, 1987; Hastie & Park, 1986). This suggests that when subjects are simply asked to think about a particular target in the absence of new information about him or her, their evaluation of the target will reflect whatever previously encoded cognitive elements concerning the target are activated. It follows that as the configuration of cognitive elements changes, the overall evaluation of the target is likely to change as well. Thus, as different subsets of thoughts concerning, say, an acquaintance succeed each other in time, one is likely to experience correspondingly different evaluations of the acquaintance as well.

Of course, if the cognitive elements are all positive or all negative in valence, the temporal changes in evaluation should be minimal. Even here, however, judgment may show change, with evaluation becoming more extreme in response to the increasing number of evaluatively consistent cognitive elements that come to mind. Just such a scenario has been verified in Tesser’s (1978) research on thought polarization. This line of work has shown that with the passage of time, subjects’ evaluation of a target (e.g., a person or an activity) tends to become more extreme: An initial positive impression of a stranger, for example, becomes more positive, whereas an initial negative impression becomes more negative. Quite often, however, the cognitive elements concerning a target vary in their respective valence and thus do not promote an evaluatively consistent judgment of the target. Indeed, mixed valence and differentiation are defining features of cognitive structure (e.g., Bartlett, 1932; Haken & Stadler, 1990; Harvey, Hunt, & Schroder, 1961; Linville, 1985; Piaget, 1971; van Geert, 1991; Werner, 1957). When a representation of a target elicits conflicting assessments, or when the judge lacks a well-integrated schema concerning the target, polarization is unlikely to be observed (e.g., Liberman & Chaiken, 1991; Tesser & Leone, 1977).

This does not mean, however, that mixed-valence representations promote stability in evaluation. Stability would be expected only if both the positive and negative elements of a mixed-valence representation were activated simultaneously, giving rise to a relatively neutral evaluation (i.e., an average of the positive and negative elements) each time the judgment is assessed. It is possible, however, to envision more elaborate scenarios for mixed-valence representations than simultaneous activation. If, for example, each positive element calls to mind a negative element and vice versa, one would expect regular oscillations in the overall evaluation. If we assume further that all the elements in the representation can be activated, one would expect decreasing amplitude in these oscillations, because each new element would reflect a correspondingly smaller percentage of the overall evaluation. On the other hand, if only a relatively small subset of elements can be held in working memory and thus contribute to the overall evaluation, one would not necessarily expect decreasing amplitude in the oscillation of evaluation. Of course, more complex rules of activation could lead to considerably more irregular temporal trajectories of judgment. Even a few elements linked in a nonlinear fashion, for example, could produce very complex patterns of change characteristic of deterministic chaos (cf. Schuster, 1984).

Without monitoring evaluation over small units of time, it is impossible to discriminate among these possibilities. Thus, if no change in overall evaluation is observed for a mixed-valence representation over a 6-week or even a 10-min interval, this could mean that no change has occurred on any time scale or, alternatively, that more complex temporal trajectories of evaluation (e.g., high-frequency oscillations) have occurred on a shorter time scale but are not recorded. More generally, if only the central tendency of judgment, averaged over time, is assessed, or if the judgment is assessed at only two points in time, one cannot gauge the intrinsic dynamics of the judgment system (cf. Nowak, Lewenstein, & Vallacher, 1994). Someone about whom we feel ambivalent, for example, may promote relatively rapid (frequent) and dramatic (high amplitude) oscillations in our overall evaluation of him or her, but if our evaluation is averaged over time, it would appear that we have neutral feelings toward the person.

Unfortunately, little consideration has been given to intrinsic dynamics in social judgment. As noted, Tesser (1978) has found evidence of thought-induced polarization in judgment, but the paradigm used for this purpose does not track the judgment trajectory between the two assessment periods. Kaplowitz and Fink (1992) have explored internally generated changes in thought on shorter time scales, but their concern is not social judgment per se but rather the vacillation that occurs when a person is faced with a decision between two alternative beliefs or attitudes. Such research programs notwithstanding, most theory and research on social judgment has treated change in judgment as indicative of how new information is absorbed and integrated by the judgment system.

In view of the foregoing considerations, however, changes in judgment may also reflect the system’s internal workings. Thus, under some conditions (e.g., mixed-valence representations), changes in evaluation can be expected to occur even when no new information is encountered or when the system is unperturbed by external influences such as social pressure. From a dynamical perspective, stability in judgment thus takes on a new meaning. Rather than referring to a fixed position on a scale of measurement, stability in a dynamic sense means that the temporal trajectory of judgment follows a definite pattern, such as regular oscillation, polarization, or chaotic evolution. By the same token, a change in judgment due to external influence would be indicated by a change in the pattern, not simply by a change in a specific scale value (Kelso & DeGuzman, 1991; Nowak & Lewenstein, 1994).

To capture the intrinsic dynamics of judgment and their stability versus change, it is necessary to use dynamic measures and track them on sufficiently sensitive time scales. Such measures can be used to investigate the working and structure of the underlying judgment system. Oscillations in judgment, for example, would be indicative of a mixed-valence representa-
tion, whereas evaluative polarization would be indicative of a representation that is evaluatively consistent or in the process of becoming so. The complexity of the system, meanwhile, should be reflected in the complexity of the temporal trajectory of evaluation (cf. Eckmann & Ruelle, 1985; Grassberger & Procaccia, 1983). Fortunately, the natural sciences offer a variety of methodological and statistical tools with which to monitor and assess the time evolution of variables in complex systems (see Mandell & Selz, 1994; Nowak & Lewenstein, 1994; Schroock, 1994).

The Grassberger–Procaccia (1983) algorithm, for example, is intended to establish the dimensionality of an attractor (i.e., a pattern of behavior) in a dynamical system on the basis of the temporal trajectory of a single variable. For macroscopic descriptions of a system, this variable should be the system's order parameter. In essence, this algorithm determines how many variables are necessary to specify the state of the system. Thus, one can use this method to distinguish between a random system (i.e., a system in which the number of variables is high and tends to infinity with increasing number of measurements) and a low-dimensional deterministic system (i.e., a system in which the number of variables remains low). Within deterministic systems, meanwhile, integer dimension values indicate that the system is predictable, whereas fractional dimension values indicate that the system is chaotic and hence unpredictable over long time spans (see Grassberger & Procaccia, 1983; Nowak & Lewenstein, 1994; Schuster, 1984).

In sum, we suggest that social judgment can be viewed as a complex dynamical system. This view is consistent with the premise shared by virtually all theories of cognition that the cognitive system consists of a set of interacting elements and that the nature of these interactions produces the system's output (cf. Minsky, 1985). Because the specific cognitive elements and the feedback mechanisms among them do not vary across judges and targets, we should expect judgment systems to display various forms of behavior characteristic of other dynamical systems. For some judgment systems, we might expect little substantial change on any time scale. For other systems, however, intrinsic dynamics in the form of periodic oscillations, polarization, or chaotic evolution are to be expected.

Overview and General Hypotheses

Our goals in the present research were, first, to determine whether people demonstrate intrinsic dynamics in their evaluations of others and, second, to examine whether properties of these dynamics contain meaningful information about the social judgment system. In two studies, we induced subjects to think about target persons who were likely to elicit either positive, negative, or ambivalent feelings in them. Using a method we developed for continuously tracking judgments, we traced the trajectory of subjects' overall evaluation of the target as they thought about him or her. From these data, we derived measures to reflect both the dynamics (evaluation and changes in evaluation) and the underlying structure (dimensionality) of subjects' moment-to-moment feelings about the target. We also collected self-report measures assessing evaluation and stability of evaluation. This set of measures was used to test the following hypotheses.

Hypothesis 1: Univalent and mixed-valence representations generate different temporal trajectories of evaluation. Because univalent representations are associated with relatively stable equilibria, judgments generated by such representations should evolve toward these equilibria. For univalently positive targets, this evolution should take the form of decreasing moment-to-moment variability in evaluation and increasing positivity (polarization) over time. For univalently negative targets, there should also be decreasing moment-to-moment variability in evaluation over time, but increasing negativity rather than positivity. Because a stable equilibrium does not exist for a mixed-valence representation, neither positive nor negative polarization is expected to occur, and the moment-to-moment variability in evaluation should remain relatively high.

Hypothesis 2: Univalent and mixed-valence representations display different behavior with regard to an equilibrium state. The dynamics of a system slow down dramatically in the vicinity of an equilibrium (fixed-point attractor). In attractor neural networks, for example, the rate of changes in the system has been shown to be a powerful predictor of distance to an equilibrium point (Lewenstein & Nowak, 1989). Because equilibrium for a univalently positive target is positive evaluation, we expected that moment-to-moment variability in evaluation should be less when such a target is evaluated positively than when he or she is evaluated negatively. Conversely, because equilibrium for a univalently negative target is negative evaluation, we expected that moment-to-moment variability in evaluation should be less when such a target is evaluated negatively than when he or she is evaluated positively. Because a stable equilibrium does not exist for a mixed-valence representation, however, moment-to-moment variability in evaluation of a mixed-valence target should not depend on how he or she is evaluated.

Hypothesis 3: The temporal trajectories of evaluation can be used to infer the structure of the underlying judgment system. As noted, Grassberger and Procaccia (1983) developed an algorithm for computing the dimensionality (including fractional values) of dynamical systems. Although applied primarily to physical systems to date, this algorithm can be made applicable to psychological systems (e.g., Skarda & Freeman, 1987). Using such an application, we expected a loss of complexity (i.e., a decrease in dimension) over time for univalent but not for mixed-valence representations. This prediction reflects the progressive integration possible in a univalent representation. When such integration occurs, a single evaluation effectively captures the state of the system and thus is more likely to be stored independently of the cognitive elements that produced it.

The Mouse Paradigm

The temporal trajectories associated with social judgment can operate on various time scales, perhaps even those involving milliseconds. There are serious practical difficulties in tracking judgments on such short time scales with traditional methods. One can readily assess an attitude on a questionnaire on a given occasion and perhaps do so again a little while later (e.g., hours and minutes), but it is simply impossible to assess judgments and feelings in this way every few seconds, let alone several times a second. To get around this problem, we embraced the notion
advanced by Hovland, Janis, and Kelley (1953) that evaluation can be looked on as an implicit approach-avoid response. Viewed literally, this definition implies that a judge’s preferred proximity to a target is an expression of his or her current feeling about the target. The task then becomes one of finding a means of sampling subjects’ preferred distance from a target continuously to ascertain the moment-to-moment changes in their feelings about the target.

The paradigm we developed for this purpose involves the use of a computer mouse and two symbols presented on the computer screen: an arrow representing the subject and a small circle, positioned in the middle of the screen, representing the target of judgment. Subjects read a description of a target, or of an event involving themselves and a target, and are asked to think about the target. As they think, they adjust the arrow in relation to the target circle (by moving the mouse) so as to express their moment-to-moment feelings about the target over a 2-min period. The location of the arrow is assessed 10 times per second for a total of 1,200 potential data points. The program preserves the Cartesian coordinates of each data point, although for purposes of the research described in this article only the absolute distance from the target is considered. This distance provides a measure of subjects’ moment-to-moment feelings about the target.

Experiment 1

Method

Subjects and Design

Seventy-two undergraduates (19 men and 53 women) participated individually in exchange for credit in their psychology courses. They were asked to judge one of three target persons who varied in their valence (positive, negative, and mixed valence). Subjects judged their respective target with traditional self-report measures and with a computer mouse. Half the subjects did the self-report task first, half did the mouse task first. The design was thus a 3 (target) × 2 (task order) between-subjects factorial.

Procedure

Mouse task. Subjects were seated in front of a 386SX computer with a mouse positioned on the side of the keyboard corresponding to their dominant hand. The experimenter introduced the study as follows:

Sometimes the feelings we have about a particular person are relatively stable and don’t show much change from one moment to another, or even from one week to another week. Sometimes, though, our feelings are much less stable and do show changes over time, whether from week to week, day to day, or even within a given day. In this exercise, you will be asked to indicate your moment-to-moment feelings about someone.

The experimenter then instructed subjects in the mouse procedure. They were told that two figures would appear on the screen, a small circle (.25-in. diameter) in the middle of the screen and a small arrow adjacent to it on the left, and that these figures represented the target of judgment and themselves, respectively. The experimenter then explained their task as follows:

We want you to move the arrow in relation to the circle so as to express your overall feeling about the person. If you feel positive about the person, move yourself (the arrow) toward the person (the circle) by moving the mouse; the more positively you feel about the person, the closer you should move the arrow to the circle. If you feel negative about the person, move the arrow away from the person to represent your feelings. In other words, the distance you position yourself from the person should represent how you feel about the person.

After answering questions, the experimenter said

As you continue to think about the person, you may find that your feeling about him or her changes somewhat. If so, simply move the arrow toward or away from the person to express what your feeling is at the moment. You may adjust your position relative to the person as often, and as much, as is necessary to reflect your feeling about the person as you continue to think about him or her. It is important, of course, that you think continuously about the person as you express your feeling about the person.

Subjects were then given 20 s in which to move the mouse and observe the corresponding movement on the screen. After this practice session, the screen cleared and instructions concerning the target person appeared. Subjects in the positive target condition were asked to think about someone who fit the following description:

Imagine a close personal friend in whom you have a great deal of trust. You confide in this person and you feel comfortable sharing with him/her your most intimate problems, concerns, and aspirations. This person is one in whom you are very confident and you rely on him/her for important matters. When the “going gets rough,” you know that this person will be there for you.

The instructions for subjects in the mixed-valence target condition were as follows:

Imagine someone toward whom you are ambivalent. You have mixed feelings about this person and you can’t seem to make up your mind about him/her. There are some things you like about this person, but there are some things you don’t really care for about him/her. In general, you’re not sure what your overall feeling is about the person. On different occasions, you may have noticed feeling differently about this person.

Finally, subjects in the negative target condition were instructed as follows:

Imagine someone of whom you are very suspicious. You are never sure what this person’s motives are. Even when he/she is friendly and helpful toward you, you can’t help but wonder why he/she is behaving that way, and you tend to be wary of his/her intentions.

In each case, subjects were asked to think about someone who fit the description and to form a vivid image of that person for 30 s. Subjects were then instructed to begin the 2-min mouse procedure.

Self-report task. Either immediately before or immediately after the mouse task, subjects responded to a set of questions on the computer screen concerning the target. They were asked how positively they felt about the target, how negatively they felt about him or her, how stable their feelings were, and whether they had mixed feelings (ambivalence) about the target. They were also asked to indicate how certain they were of their responses to the positivity and negativity questions. Each question was answered on a 7-point scale with appropriately labeled endpoints.

Measures

Dynamic measures. A Fortran program was written to transform the mouse data into measures capturing basic properties of judgmental
dynamics. The most basic measure was absolute distance from the target (in pixels), which provided an indicator of overall evaluation. To characterize changes in evaluation, we measured the average speed (pixels per 0.1 s) and acceleration (changes in the number of pixels traversed in 0.1 s) of mouse movements. These measures represent only changes in absolute distance from the target (i.e., the angular components of speed and acceleration were disregarded). The speed measure indicates the average rate of change in evaluation, whereas the acceleration measure indicates changes in this rate and thus more variable dynamics. We also measured the time at rest (no. of seconds without mouse movement) in order to assess how long the system resides in the vicinity of equilibrium and nonequilibrium states.

To test predicted differences regarding movement toward equilibrium states (Hypothesis 1), we calculated the distance, speed, and acceleration during the first 40 s and again during the final 40 s of the mouse period. To test predicted differences in dynamics when close to and far from an equilibrium state (Hypothesis 2), we calculated the speed, acceleration, and time-at-rest measures separately for the vicinity of expected equilibrium states (close to the target for positive targets and far from the target for negative targets) and nonequilibrium states. To get at this distinction, we divided in half the range of distance (the span from the minimum to the maximum) used in each subject's judgment of the target. For each half, we calculated the speed, acceleration, and time-at-rest measures.

**Dimension.** The Grassberger–Procaccia (1983) method was used to calculate the dimensionality of the system generating subjects' temporal trajectories. We used a program written in C++ and tested it on computer-generated data for which dimension was known (e.g., the Lorenz attractor). Because this method gives erroneous results if the data points are too dense in time, we checked the results on the basis of randomly selected data sets (e.g., 1 and 10 points per second). As it happened, the resulting dimension scores stabilized most readily for calculations based on every second data point (i.e., 5 per second). In subsequent analyses, then, dimension scores were calculated on these data points. These calculations were performed for each embedding dimension between 1 and 40. If the dimension score failed to stabilize for lower embedding dimensions, we used the score obtained for the highest embedding dimension. We calculated dimension separately for the first 40 s and the last 40 s. The dimension scores ranged from 0 to 8.22 for the early period ($M = 1.66, SD = 1.71$) and from 0 to 5.85 for the late period ($M = 0.96, SD = 1.23$).

We should note that human decision is required to separate regions reflecting noise (error variance) from the region reflecting true dynamics in the function produced by the Grassberger–Procaccia (1983) procedure. Clear guidelines are available for making this determination (Ben Mizarahi, Procaccia, & Grassberger 1984). Nonetheless, to minimize subjectivity two trained raters (who were unaware of the hypotheses) independently assessed which region of the function generated by the computer would produce the most reliable estimate of dimension. In cases of disagreement (about 10%), the raters discussed their assessments until they reached agreement. Also, because the calculation of dimension excluded half the data points (i.e., every second point), we recalculated dimension on the excluded data to yield a second set of scores. The two sets were highly correlated across subjects, $r(71) = .88$ and .82, respectively, for early and late scores ($p < .001$), suggesting that the dimension measure is reliable.

**Self-report.** A factor analysis (principal-components with varimax rotation) performed on the six self-report questions revealed two factors with eigenvalues greater than 1.0: Positivity, consisting of the positivity and negativity items (factor loading = .92 for each), and Stability, consisting of the stability item, the ambivalence item, and the two certainty items (factor loadings = .52–.87). The items comprising each factor were averaged (after reverse scoring when necessary) to create measures of positivity and stability for each subject.

### Results

**Preliminary Analyses**

We plotted the absolute distance from the target over the 2-min period for each subject. Observation of the set of figures revealed a variety of temporal trajectories, including periodic oscillations, seemingly chaotic evolution, intermittent bursts of change amidst periods of no change, and initial changes that gave way to no change. Six subjects (2 in each condition) made virtually no mouse movements during the 2-min period. The data from these subjects were nonetheless retained for the analyses. Figures 1, 2, and 3 present the absolute Distance $\times$ Time displays for a representative subject in each of the three target conditions. These figures obviously do not represent tests of the hypotheses but rather are intended to give the reader a feel for the sorts of temporal trajectories observed.

**Tests of the Hypotheses**

Correlational analyses were performed to assess whether the relationships among the various measures were notably different as a function of sex or task order. Overall, these variables made negligible differences in the relationships obtained. We also performed separate analyses of variance (ANOVA$s$) on the measures as a function of target valence for each level of sex and task order. Again, results revealed that these variables did not meaningfully affect the pattern of effects obtained. The data therefore are collapsed across sex and task order in the analyses reported.

**Evolution toward equilibrium.** To test the predictions regarding evolution toward equilibrium (Hypothesis 1), we performed 3 (target) $\times$ 2 (time) ANOVAs on distance, speed, and acceleration, with repeated measures on the second factor (i.e., early vs. late). For distance, results revealed a reliable Target $\times$ Time interaction, $F(2, 70) = 4.68, p < .01$. There was a reliable decrease in distance over time for the positive target, $t(24) = 2.44, p < .02$, indicative of positive polarization, a marginally reliable increase in distance for the negative target, $t(23) = 1.97, p < .06$, suggestive of negative polarization, but no change in distance for the mixed-valence target (see Table 1). These data suggest that the judgment system tends to move toward equilibrium over time, provided a stable equilibrium exists for the system.

A marginally reliable Target $\times$ Time interaction was also observed for speed, $F(2, 70) = 2.87, p < .07$. The pattern of means underlying this interaction (see Table 1) indicates that the rate

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1. Inspection of subjects' mouse movements revealed that virtually all subjects spent the first few seconds moving from the initial position (immediately adjacent to the target) to a "safe" starting position. For this reason, subjects' movements during the first 3 s were not analyzed. The variables were thus calculated on subjects' mouse movements (approximately 1,070 data points) during the remaining 1-min, 57-s period.

2. We thank Michal Zochowski of the Center for Theoretical Physics, Polish Academy of Science, Warsaw, Poland, for writing this program.
of change in evaluation decreased over time for both the positive target, \( t(24) = 2.11, p < .05 \), and the negative target, \( t(23) = 3.59, p < .002 \), but not for the mixed-valence target \( (t < 1) \). A marginally reliable interaction of the same form was observed for acceleration, \( F(2, 70) = 2.39, p < .10 \). The rate of change in evaluation stabilized over time for the negative target, \( t(23) = 4.24, p < .003 \), tended to stabilize for the positive target, \( t(24) = 1.88, p < .08 \), but did not stabilize for the mixed-valence target \( (t < 1) \); see Table 1). In accordance with Hypothesis 1, then, the judgment system tended to settle into a slower and more regular pattern of evaluation over the 2-min period, but only for targets associated with a single equilibrium state.\(^3\)

Proximity to equilibrium. ANOVAs were performed to assess the effect of target on speed, acceleration, and time at rest when close to versus far from the target. Results revealed reliable Target \( \times \) Proximity interactions for speed, \( F(2, 70) = 6.60, p < .01 \); acceleration, \( F(2, 70) = 3.57, p < .05 \); and time at rest, \( F(2, 70) = 16.70, p < .001 \). To test the predictions regarding proximity to equilibrium, we compared the close versus far scores for speed, acceleration, and time at rest for each of the targets (see Table 2). Both speed and acceleration were greater with respect to the negative target when close to, as opposed to far from, the target, \( r_s(24) = 2.84, p < .02 \), and 1.76, \( p < .05 \), respectively. For the positive target, though, speed and acceleration were greater when far from, as opposed to close to, him or her, \( r_s(24) = 1.91 and 2.28 (both ps < .05) \), respectively. Time at rest, meanwhile, was greater when close to, as opposed to far from, the positive target, \( t(24) = 2.95, p < .005 \), but greater when far from the negative target, \( t(24) = 2.65, p < .01 \).\(^3\)

Results of these analyses also revealed a reliable target effect for distance, \( F(2, 70) = 36.3, p < .001 \). Subjects positioned themselves closer to the positive target than to the other targets and closer to the mixed-valence target than to the negative target \( (p < .01 \) in each case). The target effects for speed and acceleration were only marginally reliable \( (p < .15) \), although the mixed-valence target promoted reliably greater speed and acceleration than did the positive target \( (p < .05 \) in both cases).
Keeping in mind that the expected equilibrium for the negative target was distant from the target, whereas the expected equilibrium for the positive target was close to the target, these data are in accord with Hypothesis 2 regarding the loss of dynamics when the judgment system is the vicinity of an equilibrium. At the same time, however, because there was no stable equilibrium for the mixed-valence target, there should be no difference in speed, acceleration, and time at rest as a function of distance from the target, and this is what the data in Table 2 indicate.

\textit{Dimension.} We performed a 3 (target) $\times$ 2 (time) ANOVA on dimension, with repeated measures on the second factor. Results revealed a highly reliable effect for time, $F(2, 70) = 15.80$, $p < .001$. Table 3 reveals that for both the positive and negative targets, there was a loss in dimension over time, $t(24) = 2.91$ and $t(23) = 3.07$ (both $p < .01$), respectively. For the mixed-valence target, however, dimension did not decrease from the beginning to the end of the mouse period ($t < 1$).

\textit{Dynamics and self-report.} Correlational analyses were performed to assess the relation between self-reported judgments of the target and changes in the dynamic measures over the 2-min period (i.e., early minus late scores). Because of the restriction in range in evaluation for each target, these analyses were performed with the data collapsed across the three targets. The results revealed that positivity was correlated with decreased distance, $r(71) = .26$, $p < .05$, whereas stability was correlated with decreased speed, $r(71) = .29$, $p < .05$; acceleration, $r(71) = .25$, $p < .05$; and dimension, $r(71) = .18$, $p < .10$. Thus, positive polarization in intrinsic dynamics was reflected in self-reported positivity toward the target, whereas decreased variability and complexity in intrinsic dynamics was associated with self-report indications of integrated evaluation.

The self-report measures were also analyzed in one-way ANOVAs. As Table 4 indicates, the pattern of means for positivity differed from that obtained for stability. For positivity, results reflected the relative positivity of the targets: The positive target was viewed more favorably than the mixed-valence target, who in turn was viewed more favorably than the negative target.
For stability, however, results reflected the consistency as well as the positivity of target valence. Thus, although the positive target promoted greater stability than the negative target, both the positive and negative targets promoted greater stability than the mixed-valence target.

**Discussion**

The data obtained in Experiment 1 provide encouraging support for the notion of intrinsic dynamics in social judgment. Almost all subjects demonstrated moment-to-moment variation in their feelings about a target person, and key properties of this variation conformed to the hypotheses. For the univalent positive and negative targets, there was evolution toward a relatively stable equilibrium over the 2-min period, and differential dynamics were observed depending on the judgment system's proximity to this equilibrium. For the mixed-valence target, however, results suggested that the judgment system lacked a stable equilibrium: The moment-to-moment variation in evaluation remained relatively high throughout the judgment period and did not differ as a function of proximity to the target. The results for dimension revealed a loss of system complexity over time for univalent targets but not for mixed-valence targets. One possible interpretation is that the system generating judgments of univalent targets became highly integrated by the end of the judgment period, whereas the system generating judgments of mixed-valence targets remained unintegrated.

The results obtained for the self-report variables, meanwhile, provided insight into the phenomenal states associated with judgmental dynamics. Liking for targets was expressed in polarization over the 2-min period, whereas uncertainty and ambivalence were expressed in the persistence over time in moment-to-moment variability in evaluation. Subjective certainty, meanwhile, was associated with a loss of complexity in the system generating subjects' moment-to-moment evaluations.

Because Experiment 1 represents the initial experiment conducted within the mouse paradigm, the results obtained can hardly be considered definitive. To provide additional support
Table 1

Mouse Measures by Target Valence and Time: Experiment 1

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<th>Time</th>
<th>Target valence</th>
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<td>Positive</td>
<td>Mixed</td>
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<td>Absolute distance (pixels)</td>
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<td>Early</td>
<td>33.8</td>
<td>122.5</td>
<td>193.8</td>
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<td>Late</td>
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<td>Speed (pixels per second)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>1.80</td>
<td>2.80</td>
<td>2.90</td>
<td></td>
</tr>
<tr>
<td>Late</td>
<td>0.64</td>
<td>3.50</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;.05</td>
<td>ns</td>
<td>&lt;.002</td>
<td></td>
</tr>
<tr>
<td>Acceleration (change in pixels per second)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>2.56</td>
<td>6.18</td>
<td>6.41</td>
<td></td>
</tr>
<tr>
<td>Late</td>
<td>1.93</td>
<td>8.18</td>
<td>2.55</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;.08</td>
<td>ns</td>
<td>&lt;.003</td>
<td></td>
</tr>
</tbody>
</table>

Note. n = 24 in each target valence group. p values represent results of t tests comparing Early and Late means for each Target Valence group.

Table 2

Mouse Measures by Target Valence and Proximity: Experiment 1

<table>
<thead>
<tr>
<th>Proximity</th>
<th>Target valence</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Mixed</td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Speed (pixels per second)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close to target</td>
<td>0.28</td>
<td>3.94</td>
<td>4.81</td>
<td></td>
</tr>
<tr>
<td>Far from target</td>
<td>2.52</td>
<td>3.89</td>
<td>1.85</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;.05</td>
<td>ns</td>
<td>&lt;.05</td>
<td></td>
</tr>
<tr>
<td>Acceleration (change in pixels per second)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close to target</td>
<td>0.99</td>
<td>9.81</td>
<td>8.50</td>
<td></td>
</tr>
<tr>
<td>Far from target</td>
<td>4.63</td>
<td>8.21</td>
<td>5.67</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;.05</td>
<td>ns</td>
<td>&lt;.05</td>
<td></td>
</tr>
<tr>
<td>Time at rest (in seconds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close to target</td>
<td>66.5</td>
<td>29.1</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>Far from target</td>
<td>11.0</td>
<td>29.4</td>
<td>55.2</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;.005</td>
<td>ns</td>
<td>&lt;.01</td>
<td></td>
</tr>
</tbody>
</table>

Note. n = 24 in each target valence group. p values represent results of t tests comparing Close to and Far from Target means for each Target Valence group.

Table 3

Dimension by Target Valence and Time: Experiment 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Target valence</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Mixed</td>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>1.81</td>
<td>1.41</td>
<td>1.76</td>
<td></td>
</tr>
<tr>
<td>Late</td>
<td>1.03</td>
<td>1.15</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;.01</td>
<td>ns</td>
<td>&lt;.01</td>
<td></td>
</tr>
</tbody>
</table>

Note. n = 24 in each target valence group. p values represent results of t tests comparing Early and Late means for each level of Target Valence.

for our hypotheses, we conducted a conceptual replication that dealt with three procedural issues concerning Experiment 1. The first issue concerns the manipulation of target valence. Although we instructed subjects to think about particular individuals who fit the descriptions provided, the abstract nature of these descriptions may have allowed for more than one target to be evaluated during the judgment period. Subjects may have considered two or more targets they considered trustworthy, for example, and judged each of them as they came to mind. If so, the temporal variation observed may have reflected subjects’ stable evaluation of different targets rather than changing evaluation of a single target (as intended). 4

The second issue also concerns the target manipulation. Although we instructed subjects to think about particular individuals who fit the descriptions provided, the abstract nature of these descriptions may have allowed for more than one target to be evaluated during the judgment period. Subjects may have considered two or more targets they considered trustworthy, for example, and judged each of them as they came to mind. If so, the temporal variation observed may have reflected subjects’ stable evaluation of different targets rather than changing evaluation of a single target (as intended). If subjects’ movements reflected this aspect of suspicion rather than negativity per se, Experiment 1 may not have provided a fair test of univalence versus mixed valence with respect to intrinsic dynamics.

The third issue concerns the freedom of mouse movement. Although we instructed subjects to think about particular individuals who fit the descriptions provided, the abstract nature of these descriptions may have allowed for more than one target to be evaluated during the judgment period. Subjects may have considered two or more targets they considered trustworthy, for example, and judged each of them as they came to mind. If so, the temporal variation observed may have reflected subjects’ stable evaluation of different targets rather than changing evaluation of a single target (as intended). 4

4 This point was recognized as well by one of the anonymous reviewers.
Note. \( n = 24 \) in each Target Valence group. \( F \) values represent main effects of target valence for each measure. Means in a row not sharing a common subscript differ at \( p < .05 \) in follow-up \( t \) tests.

Table 4
Self-Report Measures by Target Valence: Experiment 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>Positive</th>
<th>Mixed</th>
<th>Negative</th>
<th>( F(2, 70) )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positivity</td>
<td>6.28 ( b )</td>
<td>3.90 ( b )</td>
<td>2.54 ( b )</td>
<td>56.28</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Stability</td>
<td>5.91 ( b )</td>
<td>3.79 ( b )</td>
<td>5.13 ( b )</td>
<td>22.09</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

As in Experiment 1, we assessed the reliability of dimension scores by recalculating them for the remaining 5 data points per second and correlating the two sets of scores across subjects. The dimension scores were again highly correlated, \( r(35) = .91 \) and \( .92 \) for early and late scores (\( p < .001 \)).

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**Experiment 2**

**Method**

**Subjects and Design**

Thirty-six undergraduates (12 men and 24 women) participated individually in exchange for credit in their psychology courses. They judged one of four target scenarios representing the factorial crossing of the judgment period for the univalent targets but not for the mixed-valence targets. We also expected to find differences in judgmental variability as a function of distance from equilibrium for the univalent targets. Specifically, we expected greater speed and acceleration and less time at rest when far from, as opposed to close to, the positive targets but the opposite effects for the negative targets. Because mixed-valence targets are presumed to lack a single equilibrium, the variability measures were not expected to differ as a function of distance from these targets. We also expected a decrease in dimension over time for the univalent targets but not for the mixed-valence targets. Finally, the self-report measures were expected to vary as a function of target valence and to covary with the dynamic measures in the same manner as that observed in Experiment 1.

**Procedure**

**Mouse task.** Subjects were instructed to use the mouse in the same way as were subjects in Experiment 1, except that they were told to confine their movements to the horizontal axis extending from the target in the direction of their dominant hand (e.g., to the right for right-handed subjects). During the 20-s practice session, only the horizontal component of mouse movements was displayed on the monitor; any vertical movement simply left the position of the cursor unchanged (except, of course, for any associated horizontal movement). Subjects seemed to experience no difficulty in moving the mouse in accordance with these instructions.

After the practice period, the screen cleared and one of the four target–behavior descriptions appeared. The liked acquaintance was described as someone the subject knew well and liked a great deal. The disliked acquaintance was described as someone the subject knew well and did not like very much. In both cases, subjects were told to think of a specific person of the same sex who fit the description and to verbalize that person’s name to themselves. Subjects then were asked to imagine that the target had committed either a good act (finding a wallet with \$20 and spending time locating the owner) or a bad act (stealing \$20 from a mutual acquaintance and never admitting to the act).

**Self-report task.** Subjects responded to the same set of questions as those in Experiment 1 (positivity, negativity, certainty for both positivity and negativity, ambivalence, and stability of feelings). The questions were presented on the monitor either immediately before or immediately after the mouse task.

**Results**

**Preliminary Analyses**

As in Experiment 1, we plotted the absolute distance from the target over time for all subjects. The temporal trajectories revealed in these graphs were highly similar to those obtained in Experiment 1, as the analyses reported below indicate. However, 9 rather than 6 subjects in this experiment displayed virtually no mouse movements during the 2-min period. These subjects, whose data were retained for analysis, were fairly evenly distributed across conditions.

**Tests of the Hypotheses**

We tested for sex and order effects, as in Experiment 1. For the most part, these variables made negligible differences in both the correlations obtained among the various measures and the pattern of means for these measures across the target-behavior conditions. The data are therefore collapsed across these variables in the reported analyses.

**Evolution toward equilibrium.** ANOVAs on the mouse variables provided support for the hypotheses concerning evolution toward equilibrium. For distance, there was a reliable Behavior...
× Time interaction, $F(1, 32) = 10.32, p < .003$. This effect reflected negative polarization over time for acquaintances performing the bad act ($M = 169.0$ and $192.5$ for early vs. late), $t(15) = 2.96, p < .009$, and a tendency toward positive polarization for acquaintances performing the good act ($M = 41.8$ and $33.4$), $t(15) = 1.67, p < .10$. Results also revealed a reliable three-way interaction of target, behavior, and time for acceleration, $F(1, 32) = 5.57, p < .03$, and a marginally reliable three-way interaction for speed, $F(1, 32) = 2.74, p < .10$. To assess the hypothesis regarding loss of dynamics for univalent but not for mixed-valence targets, we regrouped the data into univalent (liked/good and disliked/bad) and mixed-valence (liked/bad and disliked/good) combinations. The ANOVA on these data revealed a reliable Valence × Time interaction for acceleration, $F(1, 34) = 5.69, p < .02$, and a marginally reliable interaction for speed, $F(1, 34) = 2.91, p < .08$. We then compared the early and late measures for each combination for these variables (see Table 5). In the univalent condition, there was a reliable decrease in both speed, $t(17) = 3.27, p < .005$, and acceleration, $t(17) = 2.85, p < .01$. Neither variable showed a decrease in the mixed-valence condition ($t < 1$). Like the corresponding results obtained in Experiment 1, these data suggest that the judgment system tends to move toward equilibrium over time, provided a stable equilibrium exists for the system.

Proximity to equilibrium. ANOVAs were performed to assess the effects of target and behavior on speed, acceleration, and time at rest when close to versus far from the target. Results revealed a Target × Proximity interaction for speed, $F(1, 32) = 4.18, p < .05$, and acceleration, $F(1, 32) = 4.43, p < .05$, and a Behavior × Proximity interaction for speed, $F(1, 32) = 3.95, p < .05$; acceleration, $F(1, 32) = 3.37, p < .08$; and time at rest, $F(1, 32) = 17.28, p < .001$. To test the predictions regarding proximity to equilibrium, we compared the close versus far scores for these measures for each combination of target and behavior. The results were consistent with the results obtained in Experiment 1 and provided support for Hypothesis 2 (see Figures 4, 5, and 6). In the univalent conditions (liked/good and disliked/bad), all three measures differed reliably as a function of proximity to the target (all $p < .05$), whereas in the mixed-valence conditions (liked/bad and disliked/good) only one reliable difference ($p < .05$) was obtained (time at rest for disliked/good). Thus, the turnover in feelings regarding a target tended to diminish when the momentary output of judgment was near an equilibrium state, provided an equilibrium state existed for the target.

Dimension. An ANOVA on dimension revealed a reliable effect for time, $F(1, 32) = 8.84, p < .006$, and a marginally reliable three-way interaction of target, behavior, and time, $F(1, 32) = 2.72, p < .10$. To test whether the pattern of means underlying this effect is consistent with the hypothesized decrease in dimension for univalent but not mixed-valence targets, we regrouped the data into univalent and mixed-valence combinations and compared the early and late measures for each combination (see Table 6). Results revealed a reliable decrease in dimension for the univalent condition, $t(21) = 3.94, p < .001$, but not for the mixed-valence condition ($t < 1$).

Dynamics and self-report. As in Experiment 1, we performed correlational analyses to assess the relation between the self-report measures and changes in the mouse measures from early to late. Because these analyses revealed essentially the same pattern of correlations for each target–behavior condition, we collapsed across conditions to increase power and recomputed the correlations. Positivity was associated with polarization (decreased distance from early to late), $r(35) = .49, p < .01$, and decreased dimension, $r(35) = .25, p < .06$. Self-reported stability was associated with decreased speed, $r(35) = .18, p < .10$, and decreased acceleration, $r(35) = .25, p < .05$. These results corroborate those obtained in Experiment 1 and confirm that intrinsic dynamics are reflected in subjects’ phenomenology.

ANOVA performed on the self-report measures also produced results consistent with those obtained in Experiment 1. Positivity was greater for the liked than for the disliked acquaintance ($M = 4.64$ vs. $2.72$), $F(1, 32) = 37.2, p < .001$, and for acquaintances who did the good as opposed to the bad act ($M = 5.39$ vs. $1.97$), $F(1, 32) = 118.2, p < .001$. For self-reported stability, there was a reliable Target × Behavior interaction, $F(1, 32) = 11.96, p < .03$. To test whether the pattern of means underlying this interaction reflects greater stability for univalent as opposed to mixed-valence target–behavior descriptions, we regrouped the data into univalent and mixed-valence combinations and performed a one-way ANOVA. Results demonstrated that stability was reliably greater in the univalent than in the mixed-valence condition ($M = 5.24$ vs. $4.08$), $F(1, 34) = 5.37, p < .03$. $^6$ Results for distance also revealed main effects for target, $F(1, 32) = 15.66, p < .001$, and behavior, $F(1, 32) = 60.25, p < .001$. Not surprisingly, less distance was maintained from the liked as opposed to the disliked acquaintance ($M = 72.7$ vs. $145.7$) and for the acquaintance engaging in a good as opposed to a bad act ($M = 37.6$ vs. $180.8$).
Discussion

These data corroborate the results obtained in Experiment 1 and thus lend additional credence to the notion of intrinsic dynamics in social judgment. It is noteworthy that the same pattern of effects was obtained despite the use of a different manipulation of target valence and a more constrained mouse procedure. Subjects apparently were sensitive to the valence and evaluative consistency of the targets they were asked to think about and were able to express their moment-to-moment feelings about the targets in a highly discriminating manner that provided support for the hypotheses.

Beyond providing a conceptual replication of Experiment 1, this study indicates that the expression of both momentary fluctuations and longer term changes in evaluation (e.g., polarization) are robust across procedural variations in the mouse paradigm. Overall, the dimension scores were lower in this study than in Experiment 1, but it is unclear whether this difference reflects the difference in mouse procedures or the differences in the manipulation of the target variables. In any event, the pattern of results is essentially the same for the two experiments. Further research on this matter is necessary, of course, but for the present it appears that constraining subjects to horizontal movement does not change the meaning of the mouse task for subjects. Conversely, allowing subjects to move the mouse in any manner they choose does not seem to introduce substantial noise into subjects' expression of moment-to-moment feelings about a target. Either method, then, may be suitable for tracking the trajectory of social judgment.

General Discussion

Taken together, the data obtained in Experiments 1 and 2 provide support for the idea that under some conditions, social judgment displays intrinsic dynamics and that the mouse paradigm represents a viable and potentially useful means of gaining insight into such dynamics. Below we highlight some implications of the results obtained and then we turn our attention to

Table 6
Dimension by Target–Behavior Valence and Time: Experiment 2

<table>
<thead>
<tr>
<th>Target–behavior valence</th>
<th>Time</th>
<th>Univalence</th>
<th>Mixed valence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early</td>
<td>1.04</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>Late</td>
<td>0.44</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>( p )</td>
<td>&lt;.001</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

Note. Univalence groups consisted of liked acquaintance/good behavior and disliked acquaintance/bad behavior conditions. Mixed-valence groups consisted of liked acquaintance/bad behavior and disliked acquaintance/good behavior conditions. \( n = 18 \) in each group. \( p \) values represent results of \( t \) tests comparing Early and Late means for each level of Target–Behavior valence.
The present research suggests that social judgment can be profitably viewed as an instantiation of a dynamical system. Still, pending further research on this matter, the simultaneous conflict interpretation of ambivalence should not be dismissed.

A related, but somewhat broader, issue concerning the nature of mouse movements should be noted. Although these movements are said to reflect the moment-to-moment dynamics of social judgment, they could be interpreted in terms of output effects rather than judgment processes per se. Conceivably, subjects begin the mouse task with a clear and stable judgment of the target person but require time to translate this judgment into a fixed point in the target circle. In this view, the mouse movements represent attempts at calibrating one's judgment with respect to an undefined scale of measurement. This possibility clearly warrants explicit attention in future research, although it is not immediately obvious how an output scaling interpretation could account for the pattern of effects we predicted and obtained across conditions or for the correlations we observed between the mouse measures and the self-report variables.

The mouse measures we used in the present research were derived from intuition to express basic features of dynamics and organization in social judgment. Thus, distance provided a straightforward measure of evaluation, speed captured the rate of turnover in evaluation, acceleration provided a measure of instability in the trajectory of evaluation, and dimension assessed the complexity of the representation generating the observed dynamics. In view of the largely confirmatory results obtained, it is fair to say that these measures did what we expected them to. However, it is also the case that a more precise and definitive understanding of what these measures represent psychologically must await future research extending the mouse paradigm to a cross-section of social judgment phenomena. Such research might indicate as well that other measures derived from mouse movements capture important features of mental dynamics and organization.

A focus on dynamics and organization does not substitute for more traditional approaches emphasizing content and meaning. Thus, a concentration on likely order parameters (such as evaluation) offers insight into the intrinsic dynamics and structural complexity of a social judgment system, but necessarily sacrifices information about the content of specific cognitive elements. Research focusing on the temporal sequence of specific elements of thought (e.g., memories of traumatic events), on the other hand, is useful in highlighting idiosyncratic features of mental content and process (cf. Pope & Singer, 1978; Uleman & Bargh, 1989), but this very idiosyncrasy may pose a problem for establishing general rules governing the workings of the social judgment system. To capture fully the nature of social judgment, then, approaches emphasizing dynamics and those emphasizing content are both essential and should be considered complementary.

Metatheoretical Implications

The present research suggests that social judgment can be profitably viewed as an instantiation of a dynamical system.

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7 This point was brought to our attention by one of the anonymous reviewers.

8 One of the anonymous reviewers raised this possibility.
Like dynamical systems in other areas of science, social judgment can be described in terms of multiple lower level elements (thoughts, memories, and images) that interact in some fashion (e.g., averaging, spreading activation, and inhibition) to produce macrolevel behavior (e.g., evaluation). Dynamical systems also commonly display internally generated changes over time in their macrolevel behavior, and the data we obtained suggest that social judgment fits this criterion as well. Within the mouse paradigm, changes in evaluation—the proposed macrolevel behavior for social judgment—can be characterized in the same manner that the changes in any dynamical system's behavior can be characterized in (e.g., speed, acceleration, proximity to an equilibrium state, and dimensionality). Variation in these properties, moreover, was found to correspond to principles at work in a wide variety of dynamical systems (e.g., the dampening of dynamics in the vicinity of an equilibrium state).

By framing social judgment in dynamical terms, one can re-examine long-standing issues with the benefit of procedures and tools available in other areas of science. The nature of stability versus change is arguably the most fundamental issue in social judgment (cf. Eiser, 1990; Fiske & Taylor, 1991), and it is also the focus of much of the work on dynamical systems (e.g., Glass & Mackey, 1989; Haken, 1984). The typical approach to this issue in psychology involves exposing subjects to new information, some form of social influence, or both, to see whether their judgments remain stable or shift to some new (presumably stable) position. Obviously, judgments can and do change in response to external factors, and much of value has been learned from this line of research. The dynamical systems perspective, however, alerts us to the potential for intrinsic dynamics in a complex system such as social judgment. Thus, by observing how subjects' global assessment of a target unfolds in real time without external influence, one gains new insight into the nature of stability versus change in social judgment. This approach, for instance, demonstrates that stability can refer to reliable patterns of change (e.g., periodic oscillation between conflicting evaluations) as well as to fixed positions.

Observing the time trajectory of a single variable in a system that evolves without external influence is only one way of analyzing the behavior of a dynamical system. An alternative approach for gaining insight into dynamics is to analyze the stability of the system under perturbation. Within the mouse paradigm, for example, one could examine the effects of persuasion by introducing new and inconsistent information regarding a target at some point during subjects' moment-to-moment consideration of the target. Presumably, if such information had the intended effect of changing subjects' global evaluation of the target, it would do so by perturbing the existing dynamics, thereby creating the precondition for a different dynamic pattern to emerge that would accommodate the new information. By tracking subjects' feelings on a moment-to-moment basis, the transition from one dynamic pattern to another as subjects reorganize their thoughts could be documented.

Because the present research represents an initial attempt to frame social judgment in dynamical terms, we purposely limited our focus to very basic properties of temporal dynamics (e.g., speed and acceleration). A wide variety of other tools and methods are available for analyzing the properties of dynamical systems, however, and many of these may have application to psychological data (cf. Abraham, 1990; Vallacher & Nowak, 1994), including the type of data obtained within the mouse paradigm. Thus, in addition to assessing the dimensionality of a system (as in the present research) with the Grassberger–Procaccia (1983) algorithm, it is possible to identify temporal patterns through coherent state analysis and Fourier analysis (Schroock, 1994), to test for determinism or the lack thereof with an algorithm developed by Kaplan and Glass (1992), and to assess the complexity of temporal trajectories with measures of topological and metric entropy (Mandell & Selz, 1994). Clearly, the application of these and yet other methods to social judgment data is a priority for future research.

In the natural sciences, the dynamical systems perspective has proven to be an extremely rich set of heuristics that has promoted the integration of diverse topics into a coherent set of principles (cf. Gleick, 1987; Haken, 1984; Yates, 1987). We hope that this perspective will serve a similar function for the various domains of social judgment. Thus, the mouse paradigm and the metatheoretical orientation it represents could be extended to such diverse topics as self-evaluation, attitude formation, stereotyping, moral evaluation, action identification, and causal attribution. Such research might reveal new insights into the mental dynamics associated with each of these phenomena and establish basic commonalities among them (e.g., the dynamics associated with transitions from one state to another). In short, the investigation of different phenomena within a common paradigm provides a means of identifying both what is unique about each and what is invariant across them and thus representative of social thinking generally.

References


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