

## Velocity Relation: Satisfaction as a Function of the First Derivative of Outcome Over Time

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Social scientists have found that satisfaction with an outcome is positively related not just to the position (i.e., actual level) of the outcome, but also to the displacement (i.e., directional difference) between the current level and a reference level. Extending the displacement notion, the present research hypothesized that satisfaction is positively related to the velocity (i.e., rate) at which the outcome changes over time, and tested this hypothesis by using hypothetical outcomes presented in questionnaires (Study 1) and displayed on a computer screen (Study 2). Results from both studies supported the hypothesis. The findings are discussed with regard to their implications for a formal model of the outcome-satisfaction relationship and for a dynamic analysis of human behavior.

The present research investigates the relation(s) between the desired outcome of an event and the satisfaction of the person who experiences the event. For example, what is the relation between the grade point average (GPA) of a student and his satisfaction with his grade? What is the relation between the salary of a worker and her satisfaction with her salary? What is the relation between the amount of fame an actor has and his satisfaction with it? What is the relation between the weight of a dieter and her satisfaction with her weight?

We believe that there exists more than one relation between outcome and satisfaction. Probably the simplest relation is that satisfaction depends on the actual value of the outcome: The more (less) positive an outcome, the greater (less) the satisfaction.<sup>1</sup> For example, the higher the GPA, the more satisfied a student is with it; the higher the salary, the more satisfied a worker is with it. Formally, this relation can be expressed as

$$S = F_0(P), \quad (1)$$

where  $S$  is the degree of satisfaction,  $F_0$  is a monotonically increasing function, and  $P$  is the actual value, or *position*, of the outcome. To distinguish this relation from the other relations to be discussed later, we shall call it the *position relation*.

A second relation between outcome and satisfaction, referred to as the *change relation*, is that satisfaction depends on the change in the outcome. Specifically, if the outcome changes toward the positive direction, then satisfaction follows; if the outcome changes toward the negative direction, then dissatisfaction follows.

For example, if a worker's salary increases, he or she will be satisfied; if it decreases, he or she will be dissatisfied. This relation is reflected in a number of social psychological theories. A familiar example is the gain-loss phenomenon (Aronson & Linder, 1965; Turcotte & Leventhal, 1984). For instance, subjects toward whom a confederate first expressed negative attitudes and then expressed positive attitudes liked the confederate more than did subjects toward whom the confederate constantly expressed positive attitudes (Aronson & Linder, 1965). Another example of the change relation in social psychology is hedonic relativity (Brickman & Campbell, 1971; Brickman, Coates, & Janoff-Bulman, 1978; Diener, 1984; Easterlin, 1973; Murray, 1988). Lottery winners, for example, reported themselves happier than others immediately after they won but not later (Brickman et al., 1978). Evidence for the change relation also comes from other areas of psychology, including utility research (e.g., Kahneman & Tversky, 1979; Loewenstein, 1988), clinical studies (e.g., Brown, MacCarthy, Gotham, & Der, 1988; Jacobs, Kasl, Ostfeld, & Berkman, 1986; Katschnig, 1986), perception experiments (Helson, 1964), and animal learning models (e.g., Crespi, 1942).

Despite its abundance, most literature has mostly emphasized one form of the change relation and overlooked another form. We propose that the change relation can be interpreted in two forms: the displacement relation and the velocity relation. By *displacement relation*, we mean that satisfaction depends on the directional distance (i.e., displacement) between the original (reference) outcome position and the position after a change. The more (less) an outcome departs from its original position in a positive direction, the greater (less) the satisfaction. By *velocity relation*, on the other hand, we mean that satisfaction at a given

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<sup>1</sup> Position, and later, displacement and velocity, can be either positive or negative. The modifier "more (less) positive" may also mean "less (more) negative."

time depends on the rate (i.e., velocity) at which the outcome is changing. The more (less) positive the velocity, the greater (less) the satisfaction. Formally,

$$S = F_1(V) \quad (2)$$

where  $F_1$  is a monotonically increasing function and  $V$  denotes the first derivative of  $P$  over time, or, simply, the velocity of  $P$ .

Although displacement and velocity both describe change, they have very different emphases: Displacement describes how much an outcome has changed; it concerns the final product of the change rather than the process or the time the process takes. In contrast, velocity describes how fast an outcome value changes; it concerns the moment-to-moment process of the change and is time sensitive. Consider an example of how these two notions can lead to different predictions. Because velocity (when it is uniform) can be defined as the quotient of displacement over the time it takes, for the same amount of displacement there can be different values of velocity depending on the time. Suppose that two persons have the same displacement of +\$200 in their savings. For one person, the time for the change is 40 days, and, hence, the velocity (suppose it is uniform) is +\$5 per day; for the other person, the time is 10 days, and, hence, the velocity is +\$20 per day. The displacement notion would predict the two persons to be equally satisfied because the final results of change are the same. On the other hand, the velocity notion would predict the second person to be happier because the velocity is more positive.

Although the above example is too simplistic, and most psychologists would probably say on reflection that time and velocity do matter, the emphasis of most existing literature is on displacement rather than on time or on velocity. In social psychology, for example, the gain-loss phenomenon is explained in terms of positive displacement (i.e., gain) and negative displacement (i.e., loss) in self-esteem (Aronson & Linder, 1965; Mettee & Aronson, 1974). The gain-loss literature does not discuss what effect the speed of gaining and the speed of losing may have. Likewise, hedonic relativity is also explained in terms of a discrepancy between the current hedonic level and a reference hedonic level (Brickman & Campbell, 1971; Diener, 1984). It is not explicated what effect the rate of change in one's hedonic value may have on happiness (cf. Quinsey, 1970). Similarly, the kind of relativism suggested in prospect theory is also a displacement-from-reference-level concept (Kahneman & Tversky, 1979). The theory does not address how the rate of change of an objective value may affect its subjective value. More generally, Diener (1984) concluded that it is the "departures" from a reference level that produce affect (p. 567). Similarly, Frijda (1988) summarized as the "law of change" of emotion that "the intensity [and direction] of emotion depends on the relationship between an event and some frame of reference against which the event is evaluated" (p. 353). These statements represent the general tendency in the existing literature to pay an extensive amount of attention to displacement but less attention to time or velocity.

There are, nevertheless, exceptions: One is Tomkins's (1984) affect theory, which explicitly regards slope (i.e., velocity) as a primary determinant of affect. However, velocity in Tomkins's theory is not identical to that in ours. For one thing, velocity in

Tomkins's theory refers to neural firing rate, a rather hypothetical concept, whereas velocity in the present research is that of a desired external outcome, a relatively tangible variable. Furthermore, Tomkins uses the concept of velocity (slope) chiefly to define states of affect (such as anger, interest, and surprise), whereas we use the concept to define valence of affect (i.e., positiveness or negativeness). Another exception to the general neglect of velocity is Carver and Scheier's (1990) control process theory. Those authors explicitly contend that affect is produced by velocity, not by absolute level or discrepancy (displacement). Again, however, the theory is different from ours. Like velocity in affect theory, velocity in control process theory is of some rather general and purely theoretical concept, that is, a meta-loop's judgment of one's progress toward a goal. Moreover, Carver and Scheier consider velocity as the primary determinant of affect; in contrast, we argue that satisfaction depends both on position and on velocity (see below for details). Finally, they did not offer any direct empirical evidence to bear on the proposed velocity-affect relation.<sup>2</sup>

The purpose of the present research was to directly test the velocity relation to examine whether satisfaction is a function of velocity rather than of just displacement. Specifically, we varied the velocity of outcomes while keeping the displacement constant and tested whether subjects responded more positively to outcomes with more positive velocities.

## Study 1

Study 1 was largely exploratory. In a questionnaire, we presented subjects with pairs of hypothetical outcomes with different patterns, particularly different velocities, and asked them to choose the one with which they were more satisfied.

## Method

### Materials

The questionnaire consisted of 15 questions. Only 7 of them were directly relevant to the issue discussed in this report, and we shall focus on these 7 questions.<sup>3</sup> Both the order of the questions and the order of outcomes within a question were counterbalanced. The questionnaire had two versions. In the salary version, the questions were about hypothetical salary from work; in the class version, the questions were about hypothetical standing in a class, as expressed in terms of percentiles.

Each of the seven questions included a pair of outcomes. The *position question*, designed to test the position relation, consisted of a pair

<sup>2</sup> One reviewer noted the apparent similarity between the present research and Parducci's range-frequency model (e.g., Parducci, 1984; Smith, Diener, & Wedell, 1989). According to that model, what influences one's feeling is not the absolute level of goodness of events, but the shape of their distribution (Diener, 1984). We feel that the relation between the two models is rather remote because the range-frequency model is chiefly concerned with the relative *frequency* of events (how often a particular event occurs as compared with others), whereas ours is interested in the relative *sequence* of events (when a particular event occurs as compared with others).

<sup>3</sup> The rest of the questions were designed to explore the effect of the *second* derivative. The results did not reveal any significant effects, but we are in the process of several other studies to investigate this factor.

of constant outcomes, one higher (i.e., more positive) than the other. The *change question*, designed to replicate the general change relation found in the existing literature (e.g., the gain-loss literature), consisted of an outcome at a constant high level and an outcome rising from a low level to the high level. The *velocity question*, designed to test the velocity relation, consisted of two outcomes that had the same displacement but different velocities (i.e., small rise versus fast rise). The *disadvantaged velocity question*, designed to test the robustness of the velocity relation against the displacement relation, consisted of an outcome with a large displacement but a less positive velocity (i.e., large/slow rise) and an outcome with a small displacement but a more positive velocity (i.e., small/fast rise). As an illustration, the two outcomes in the disadvantaged velocity question in the class version were as follows:

- A. Your standing in the class has been rising from the 30th percentile to the 70th percentile over the past 6 weeks.
- B. Your standing in the class has been rising from the 35th percentile to the 70th percentile over the past 3 weeks.

The other three questions, the *negative change question*, the *negative velocity question*, and the *disadvantaged negative velocity question*, consisted of outcomes that were the mirror images of those in the change question, the velocity question, and the disadvantaged velocity question, respectively. The left column of Table 1 summarizes the outcome patterns included in the seven questions.

### Subjects

Forty-eight Yale undergraduates participated in the study as part of their research participation requirement. Half of them received the class version of the questionnaire and the other half the salary version. Subjects were run in groups of two to four.

### Procedure

The questionnaire consisted of three pages. The first page was an instruction sheet and the next two contained the questions. The instructions asked subjects to compare the two hypothetical outcomes in each question and indicate their relative satisfaction (for the two outcomes) by circling the one with which they would be more satisfied. The instructions were followed by a sample pair of outcomes. In the class version, the sample outcomes were as follows:

- A. Your standing in the class has been rising from the 50th percentile to the 70th percentile over the past 5 weeks.
- B. Your standing in the class has been falling from the 50th percentile to the 30th percentile over the past 5 weeks.

After reading the instructions, subjects turned to the second page and started to work on the questions.

### Results and Discussion

As Table 1 shows, on the position question, 100% of our subjects chose the high outcome ( $p < .001$ , using a chi-square test). This unequivocal finding not only supported the position relation but suggested that subjects were not likely to have responded to the questionnaire haphazardly. On the change and negative change questions, significantly more subjects chose the rising outcome than the constant (high) outcome ( $p < .01$ ), and significantly more chose the constant (low) outcome than the falling outcome ( $p < .001$ ). As noted earlier, however, the implication of the findings is ambiguous; they may simply reflect the displacement relation rather than the velocity relation.

On the velocity and negative velocity questions, significantly more subjects selected the fast-rise outcome than the slow-rise outcome ( $p < .01$ ), and, symmetrically, significantly more chose the slow-fall outcome than the fast-fall outcome ( $p < .01$ ). As noted earlier, this finding was obtained when the amounts of rise or fall were kept constant; therefore, the findings could not be attributed to the displacement relation. This finding lent support to the velocity relation. Finally, on the disadvantaged velocity and negative disadvantaged velocity questions, significantly more subjects chose the fast/small-rise outcome than the slow/large-rise outcome ( $p < .001$ ), and, conversely, significantly more selected the slow/large-fall outcome than the fast/small-fall outcome ( $p < .05$ ). These results provided additional support for the velocity relation hypothesis, suggesting that the velocity effect is not only present, but also robust against the displacement effect to a certain extent.

For each question, a chi-square test was performed between the class data and the salary data. For none of the seven questions did the test reveal a significant difference between the two versions, which suggests that the relations under investigation may hold across situations.

Despite the clarity of its results, the study had a limitation. As noted earlier, a unique feature of velocity is that it is a function of time. In order to accurately assess the effect of velocity, it is probably important that subjects experience the outcome while it is actually changing in real time. Unfortunately, the procedures of Study 1 were such that the subjects only read statements about changes without having a chance to actually experience the process. This problem required us to experimentally manipulate outcomes that actually changed over time. This method was introduced in Study 2.

### Study 2

Briefly, we asked subjects to watch hypothetical outcomes graphically changing over time on a computer screen and to indicate their feelings during the procedure.

### Method

#### *The Computerized Display Method*

The study used a 12 in. color monitor controlled by a computer. At the center of the monitor screen was a vertical bar, and along the bar was a numbered scale that indicated the positions (values) of a desired outcome (see below for details). The higher the bar on the scale, the more positive the outcome it represented. The study was divided into two separate parts; each part consisted of six trials. During each trial, the bar on the screen moved vertically along the scale to portray a vivid picture of how the outcome changed over time. To dramatize the effects, a sound of varying pitch from the computer accompanied the display. Like the bar, the higher the pitch, the more positive the outcome. At a certain point, the computer stopped the display and prompted the subjects to rate their feelings at that moment on a 9-point scale ranging from *extremely satisfied* (1) to *extremely unsatisfied* (9). The response was made on a keyboard attached to the computer.

*Contexts of outcomes.* To test the generality of the velocity relation, we selected outcomes from three different contexts for this study: gambling, class, and stock. The outcome for the gambling version was the probability (expressed in percentages) that subjects would win a gamble on a hypothetical arm wrestling match. The outcome variable for

Table 1  
*Percentage of Subjects Who Chose the Predicted Alternative in Study 1*

| Type of question                                                                    | Context |       | Overall |
|-------------------------------------------------------------------------------------|---------|-------|---------|
|                                                                                     | Salary  | Class |         |
| 1. Position<br>(low vs. <i>high</i> )                                               | 100     | 100   | 100***  |
| 2. Change<br>(constant vs. <i>rise</i> )                                            | 67      | 71    | 69**    |
| 3. Velocity<br>(slow rise vs. <i>fast rise</i> )                                    | 92      | 100   | 96***   |
| 4. Disadvantaged velocity<br>(large/slow rise vs. <i>small/fast rise</i> )          | 83      | 92    | 88***   |
| 5. Negative change<br>(constant vs. <i>fall</i> )                                   | 79      | 83    | 81**    |
| 6. Negative velocity<br>(slow fall vs. <i>fast fall</i> )                           | 63      | 75    | 69**    |
| 7. Disadvantaged negative velocity<br>(large/slow fall vs. <i>small/fast fall</i> ) | 67      | 63    | 65*     |

*Note.* The description in parentheses under each question describes the patterns of the outcomes in that question. The pattern in italics is the predicted choice. The significance levels of only the overall percentages are presented; they were calculated by using chi-square tests with 50% choice determining the expected frequencies.

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$ .

the class version was the percentile standing in a hypothetical class. The outcome variable for the stock version was the price of a stock in which subjects were supposed to have invested.

*Patterns of outcomes.* For each of the two parts of the study, the six trials constituted a  $3$  (Velocity)  $\times$   $2$  (Position) design. The three velocity levels were fast, medium, and slow; the two position levels were high (i.e., more positive) and low (i.e., less positive). Displacement was kept constant across trials. The difference between the two parts was that the patterns of the six trials in Part 2 were the mirror images of those in Part 1. Take Part 1 of the gambling version, for instance. The three velocity levels were 0.3% per s (slow), 0.6% per s (medium), and 0.9% per s (fast). Note that the three levels were equally spaced, and they were so for the trials in the other two contexts. The two position levels were 60% (low) and 70% (high); that is, the winning probability at the end of the display period was either 60% or 70%. The displacement was invariably a positive 30% for all the six trials. Thus, for example, the pattern in the high/medium condition was such that the winning probability rose from 40% to 70% at a 0.6% per s rate over the display period. To make the displays more realistic, we superimposed random jiggles on the systematic patterns. For a complete description of the patterns, see the Appendix.

Depending on its velocity, the duration of the display varied from trial to trial. Specifically, duration was the quotient of displacement divided by velocity. As can be calculated from the displacements and velocities presented in the Appendix for all three contexts, the display durations for the fast, medium, and slow conditions were 33 s, 50 s, and 100 s, respectively.

*Order of displays.* Within each part, the six displays were presented in four randomized orders.

## Subjects

Thirty-six Yale undergraduates participated in the study as part of their research participation requirement. Subjects were randomly assigned to one of the 12 ( $3$  Context  $\times$   $4$  Order) conditions, with three subjects in each condition. Subjects went through both parts of the

study, and, within each part, they went through all 6 ( $3$  Velocity  $\times$   $2$  Position) trials. Subjects were run individually.

## Procedure

A male experimenter first seated the subject (let us assume that the subject was a woman) in front of the monitor and computer described above, familiarized her with the procedures, and left the experimental room. The subject started by reading a series of instructions presented on the monitor. With the gambling version as an example, she was first asked to imagine an on-going arm wrestling match on which she had bet, and then she learned how to read the display. She was told that the display represented only a portion of the entire match period and that the duration of display varied from trial to trial. Following that she practiced with an example. The pattern of the example was such that the outcome rose from 35% to 65% at a 0.6% per s rate. In order for us to establish a uniform baseline for the responses and minimize possible ceiling and floor effects, the subject was asked to regard the example as a "reference," consider its degree of satisfaction as 5 on the scale, and rate the degrees of satisfaction of the six subsequent trials in Part 1 as comparative to the example.

Before the actual trials started, the subject was reminded that the matches represented in different displays (trials) were mutually independent, that the end of a display period did not correspond to the end of a match (because the display represented only a portion of the match), and that she should base her response on how she felt at the end of the display period. After reading the instructions, the subject started working on Part 1. There was a 10-s break between trials; during the break, the screen was blank.

After finishing Part 1, the subject was given 2 min to relax, and then she started Part 2. The instructions for Part 2 basically reiterated a few points previously made. There was also an example, whose pattern was the mirror image of that of the example in Part 1. Again, the subject was asked to regard it as a reference and rate the six subsequent trials in Part 2 as compared with the example. After finishing both parts, she was debriefed.

### Results and Discussion

We analyzed satisfaction ratings from Part 1 and Part 2 separately. For each part, we performed a  $3 (3 \times 4) \times 2 \times 3$  (Subject [Context  $\times$  Order]  $\times$  Position  $\times$  Velocity) analysis of variance on the data. Table 2 summarizes the mean satisfaction ratings for the two parts.

#### Position

As expected, the analyses showed a highly significant position effect for both Part 1,  $F(1, 30) = 25.35$ ,  $p < .0001$ , and Part 2,  $F(1, 30) = 32.62$ ,  $p < .0001$ , suggesting that the more (less) positive the position, the greater (less) the satisfaction. This result was supportive of the position relation.

#### Velocity

For Part 1 of the study, where all the outcomes had positive velocities, analysis revealed a highly significant velocity main effect,  $F(2, 60) = 24.09$ ,  $p < .0001$ , suggesting that the more positive the velocity, the greater the satisfaction. Conversely and symmetrically, for Part 2 of the study, where the outcomes had negative velocities, analyses also revealed a highly significant velocity effect,  $F(2, 60) = 27.40$ ,  $p < .0001$ , suggesting that the more negative (i.e., less positive) the velocity, the less the satisfaction. These results lend strong support to the velocity relation, indicating that satisfaction does depend on the velocity of outcome even though the displacement is kept constant. The velocity relation suggests that people do not just care how much an outcome has changed, but also how fast it changes. It seems that the general displacement notion does not suffice to describe the outcome-satisfaction relation; the more accurate and specific form—the velocity relation—is needed.

The analyses did not show a significant interaction between position and velocity in either Part 1,  $F(2, 60) = 1.95$ , *ns*, or Part 2,  $F(2, 60) = 1.22$ , *ns*. Although both position and velocity influ-

ence people's satisfaction, their influences seem to be independent.

Subsequent analysis indicated that the velocity effects were almost exclusively accounted for by their linear trends in both Part 1,  $F(1, 30) = 33.95$ ,  $p < .0001$ , for linear and  $F(1, 30) = 0.90$ , *ns*, for residual, and Part 2,  $F(1, 30) = 35.43$ ,  $p < .0001$ , for linear and  $F(1, 30) = 0.11$ , *ns*, for residual, implying that, at least within a certain range, satisfaction is not only related, but linearly related, to velocity. However, one should not overgeneralize this interpretation, because the number of velocity levels included in the study was rather small, and we did not take into consideration the possibility of satiation and diminishing sensitivity when the velocity becomes very large.

#### Orders and Contexts

The analyses did not show any significant order effect, or Order  $\times$  Position or Order  $\times$  Velocity interaction, in either part. It should be noted that, theoretically, the velocity hypothesis should predict an order effect because different orders imply different velocities (slopes) *between* trials. However, the effect may not have been large enough to be detected in the present study. In addition, subjects were instructed to consider each trial as independent, and there was a break between trials.

In addition, the analyses did not reveal a significant context effect, or Context  $\times$  Position or Context  $\times$  Velocity interaction, in either part. Consistent with Study 1, the result suggests that velocity (as well as position) is a rather robust factor across diverse contexts. However, because the test was relatively weak, one should not interpret the result as implying that velocity has identical valence in different contexts.

### General Discussion

The two studies reported here have provided strong support for our hypothesis that satisfaction depends on the velocity (as well as the position) of outcome. We think that the present research has three important implications. First, it suggests a formal account of outcome-satisfaction relation(s). Second, it provides a dynamic view of outcome-satisfaction relations. Finally, it suggests a process approach to human motivation. We shall discuss these three implications separately.

#### A Formal Outcome-Satisfaction Relation

The central postulate of this article is that satisfaction is a positive function of velocity. A number of caveats are in order in interpreting this relation. First, we view the velocity relation as a prototypical account of the outcome-satisfaction relationship; we do not suggest that it is impervious to the impact of extraneous factors. For instance, a slightly injured person who wants extended sick leave may prefer a slow recovery to a fast recovery rather than vice versa.

Second, we view the velocity relation as a formal relation; in the present research, we did not intend to specify *why* people are more satisfied with a faster increase. There can be many possible reasons: For example, a faster increase may make it easier for people to anticipate a more positive position in the

Table 2  
Mean Satisfaction Ratings for the Six Trials in Part 1  
and the Six Trials in Part 2 of Study 2

| Part     | Velocity | Position |      | <i>M</i> |
|----------|----------|----------|------|----------|
|          |          | Low      | High |          |
| One      | Slow     | 6.30     | 4.58 | 5.44     |
|          | Medium   | 5.11     | 3.89 | 4.50     |
|          | Fast     | 4.42     | 3.28 | 3.85     |
| <i>M</i> |          | 5.28     | 3.92 |          |
| Two      | Slow     | 5.75     | 4.19 | 4.97     |
|          | Medium   | 6.50     | 5.39 | 5.94     |
|          | Fast     | 7.47     | 6.40 | 6.93     |
| <i>M</i> |          | 6.57     | 5.33 |          |

Note. Greater number indicates greater satisfaction. Velocities were positive in Part 1 and negative in Part 2.

near future, a faster increase may make it quicker for people to escape a relatively negative position, or a faster increase may lead people to think they are luckier or more capable than others. It awaits further research to investigate these reasons.

Third, the velocity relation only asserts that satisfaction is a monotonically increasing function ( $F_1$ ) of velocity; we do not know the exact form of the function. On the basis of utility research (see Fishburn, 1988, for a review), however, we would speculate that the function is concave when velocity is positive and convex when it is negative. In other words, the impact of velocity on satisfaction will dwindle when velocity increases toward either extreme, probably due to satiation or diminishing sensitivity.

Finally, we should note that by emphasizing velocity, we do not suggest that it is the only determinant of satisfaction. Epistemologically consistent with McGuire's (1989) perspectivism, we view the velocity relation as supplementary, not antagonistic, to the position relation. This stance is reflected in the design of Study 2 where we treated velocity and position as two separate factors. Given the results we obtained, we are now in a position to sketch a more comprehensive picture of the outcome-satisfaction relationship: Satisfaction depends both on the actual outcome position and on the velocity at which the outcome changes. Formally,

$$S = w_0 F_0(P) + w_1 F_1(V), \quad (3)$$

where  $w_0$  and  $w_1$  are weights. To some extent this formula concurs with Scitovsky's (1976) notion that satisfaction can be produced both by comfort (comparable to our position) and by pleasure (comparable to our velocity). It also concurs with Tversky and Griffin's (in press) more recent suggestion that subjective well-being (comparable to our satisfaction) is determined both by an endowment effect (comparable to our position) and by a contrast effect (comparable to our velocity, although contrast is only a displacement effect). As with endowment and contrast, however, we do not assume that position and velocity contribute equally to satisfaction, nor do we assume that the relative importance of these two factors is constant. It awaits further research to determine their relative weighting and the conditions that may influence the weighting.

### *A Dynamic Approach to Outcome-Satisfaction Relations*

In our opinion, the present research does not contribute the discovery of a new phenomenon, but a different and dynamic way of viewing an already studied phenomenon. Particularly, it emphasizes the temporal factors in the change relation, and redefines it in terms of velocity. In an insightful paper, Altman and Rogoff (1987) argued that psychology has not paid sufficient attention to time and change. These factors are either (a) totally ignored or (b) considered only as external to the studied phenomena. We think that the position relation exemplifies the case where temporal factors are totally ignored, and that the displacement relation exemplifies the second case where time and change are acknowledged, but only their end products are studied. In the same article, Altman and Rogoff advocated another view, referred to as the "transactional" approach. Accord-

ing to this approach, time and change are the very defining features of phenomena, and processes and patterns the foci of analyses. Although the discussions in that paper are largely philosophical, the velocity relation provides a concrete example of this dynamic approach.

### *A Process Approach to Human Motivation*

Finally, the present research has heuristic value for an understanding of human motivation. Recall that the velocity relation indicates that people's satisfaction depends on the velocity of an outcome over time, rather than just on the final outcome. If one goes a step further and assumes that people not only passively experience satisfaction, but actively seek satisfaction, then one can infer an interesting corollary from the velocity relation: People engage in a behavior not just to seek its actual outcome, but to seek a positive velocity of outcomes that the behavior creates over time.

It is often assumed that people behave to seek reinforcement and avoid punishment. However, there are many deviations from this rational formula of human behavior (e.g., Herrnstein, 1990; Kahneman & Varey, in press); although each of them can be explained away by adding some extra assumptions, these deviations, when put together, render the rational formula insufficient for describing human behavior and call for alternative descriptions. We believe that the corollary derived from the velocity relation can serve as one alternative description. It suggests that the outcome of an event is not the only important factor; the pattern of the outcome embedded in the process of the event is also important. People behave not just to seek the outcome of an event; they also seek a particular pattern of the event. Sometimes, for example, in order to seek a positive velocity, they may sacrifice a positive outcome or even tolerate a negative outcome. This is probably why people who engage in an apparently aversive behavior may distill great satisfaction from its process (Solomon, 1980). We agree with Schwartz's (1990) contention that human behavior is not simply a means to an end: It is simultaneously the means and the end.

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## Appendix

### Patterns of Outcomes in Study 2

| Version  | Condition   | Velocity (%) |          | Final position (%) |        | Displacement (%) |        |
|----------|-------------|--------------|----------|--------------------|--------|------------------|--------|
|          |             | Part 1       | Part 2   | Part 1             | Part 2 | Part 1           | Part 2 |
| Gambling | Slow/Low    | .3/s         | -.3/s    | 60                 | 30     | 30               | -30    |
|          | Slow/High   | .3/s         | -.3/s    | 70                 | 40     | 30               | -30    |
|          | Medium/Low  | .6/s         | -.6/s    | 60                 | 30     | 30               | -30    |
|          | Medium/High | .6/s         | -.6/s    | 70                 | 40     | 30               | -30    |
|          | Fast/Low    | .9/s         | -.9/s    | 60                 | 30     | 30               | -30    |
| Class    | Fast/High   | .9/s         | -.9/s    | 70                 | 40     | 30               | -30    |
|          | Slow/Low    | .3/s         | -.3/s    | 60                 | 30     | 30               | -30    |
|          | Slow/High   | .3/s         | -.3/s    | 70                 | 40     | 30               | -30    |
|          | Medium/Low  | .6/s         | -.6/s    | 60                 | 30     | 30               | -30    |
|          | Medium/High | .6/s         | -.6/s    | 70                 | 40     | 30               | -30    |
| Stock    | Fast/Low    | .9/s         | -.9/s    | 60                 | 30     | 30               | -30    |
|          | Fast/High   | .9/s         | -.9/s    | 70                 | 40     | 30               | -30    |
|          | Slow/Low    | \$.3/s       | -\$ .3/s | \$60               | \$30   | \$30             | -\$30  |
|          | Slow/High   | \$.3/s       | -\$ .3/s | \$70               | \$40   | \$30             | -\$30  |
|          | Medium/Low  | \$.6/s       | -\$ .6/s | \$60               | \$30   | \$30             | -\$30  |
|          | Medium/High | \$.6/s       | -\$ .6/s | \$70               | \$40   | \$30             | -\$30  |
|          | Fast/Low    | \$.9/s       | -\$ .9/s | \$60               | \$30   | \$30             | -\$30  |
|          | Fast/High   | \$.9/s       | -\$ .9/s | \$70               | \$40   | \$30             | -\$30  |

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