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Prospect theory, reference points, and health decisions

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Abstract

In preventative health decisions, such as the decision to undergo an invasive screening test or treatment, people may be deterred from selecting the test because its perceived disutility relative to not testing is greater than the utility associated with prevention of possible disease. The prospect theory editing operation, by which a decision maker's reference point is determined, can have important effects on the disutility of the test. On the basis of the prospect theory value function, this paper develops two approaches to reducing disutility by directing the decision maker's attention to either (actual) past or (expected) future losses that result in shifted reference points. After providing a graphical description of the approaches and a mathematical proof of the direction of their effect on judgment, we briefly illustrate the potential value of these approaches with examples from qualitative research on prostate cancer treatment decisions.

Keywords: prospect theory, medical decision making, reference points

1 Introduction

In preventative health decisions, such as the decision to undergo an invasive screening test or treatment, people may be deterred from selecting the test because its disutility relative to not testing is greater than the utility associated with prevention of possible disease. For example, people may feel that the anticipated disutility of a colonoscopy for colorectal cancer screening is great enough relative to the expected utilty of prevention of possible colorectal cancer to dissuade them from seeking colonoscopy.[1]

The prospect theory editing operation (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), by which a decision maker's reference point is determined, can have important impacts on the perceived disutility of the test. The work of Rothman, Salovey, and colleagues on message framing has tested prospect theory predictions of how the description of test outcomes as gains or losses (as well as the conceptualization of the purpose of the test as preventative vs. diagnostic and the consequent perception of whether the test is "safe" or "risky") can affect test rates (Rothman & Salovey, 1997; Rothman, Bartels, Wlaschin, et al., 2006). Specifically, message framing theories predict that when a procedure is perceived as risky (e.g., cancer screening tests may cause a patient to find out that they have cancer), loss-framed messages will promote testing more strongly than gain-framed messages, because people favor risky prospects over sure prospects in the domain of losses. On the other hand, when a procedure is perceived as safe (e.g., sunscreen prevents sunburn and skin cancer), gain-framed messages are predicted to be more effective because people prefer sure prospects to risky prospects in the domain of gains. Several public health intervention studies have examined message framing and generally found evidence favoring the predictions (Apanovitch, McCarthy, & Salovey, 2003; Moxey, O'Connell, McGettigan, et al., 2003; Rivers, Salovey, Pizzaro, et al., 2005; but see Finney & Iannotti, 2002 for a failure to confirm the predictions).

On the basis of the prospect theory value function, this paper develops two approaches to reducing perceived disutility by directing the decision maker's attention to

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[1] Although most of the anticipated (and experienced) disutility of colonoscopy specifically is actually associated with the preparation for the procedure rather than the procedure itself, we consider the complete experience of scheduling and undertaking a screening test, including necessary preparations, to be the "test" about which people make participation decisions.

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either (actual) past or (expected) future losses that can serve as reference points and are not consequences of the test itself. These approaches thus differ from message framing, which focuses on how the test outcomes are described and manipulates gain and loss framing. We instead derive the potential impact of directly refocusing the decision maker's reference point.

After providing a graphical description of the approaches and a mathematical proof of the direction of their effect on judgment, we illustrate the potential value of these approaches with examples from qualitative research on prostate cancer treatment decisions.

2 Graphical Description

Figure 1 depicts a stylized prospect theory value function, which defines the value associated with gains or losses from a reference point R_1, designated by the origin of the graph. The function displays the three salient characteristics of the PT value function: diminishing marginal value for gains (the gain portion of the curve is concave down), diminising marginal value for losses (the loss portion of the curve is concave up), and loss aversion (the loss curve is steeper, at all points, than the corresponding point on the gain curve).

Consider a decision maker who faces a decision between undergoing or avoiding an invasive screening procedure. The decision maker's status quo is his baseline health, shown as X_0 in Figure 1; this point is also labeled R_1 to indicate that it is the reference point from which evaluation takes place. The decision maker is evaluating the difference in value associated with the invasive procedure, shown as X_c. Δv_1 then represents the disutility that the decision maker expects as a result of undergoing the procedure.

Consider now a decision maker who faces the same decision, with the same objective outcomes (i.e., current health, X_0, or current health and an invasive procedure, X_c), but whose reference point is somehow shifted to the right (through an editing operation) relative to R_1, to the point marked R_2 on Figure 2. This decision maker, who now sees even their baseline health as poor (as X_0 is in the domain of losses relative to R_2), expects less marginal disutility from the invasive procedure, because the distance between X_c and X_0 now results in a value difference of Δv_2, which is perceived to be on a flatter portion of the loss curve, and is therefore smaller in magnitude than Δv_1. Compared with a relatively poor health state, the incremental loss associated with an invasive procedure is perceived as "less (additionally) bad."

Finally, consider a third decision maker who faces the same decision, with the same objective outcomes (i.e., current health, X_0, or current health and an invasive procedure, X_c), but whose reference point is somehow shifted to the left (through an editing operation) relative to R_1, to the point marked R_3 on Figure 2. This decision maker now interprets her baseline health, with or without an invasive procedure, as a relative gain, as X_0 and X_c are in the domain of gains relative to R_3. Therefore, the decision maker expects less marginal disutility from the invasive procedure, because the distance between X_c and X_0 now results in a value difference of Δv_3, which is perceived to be on the gain curve, which is at all points flatter than the steepest portion of the loss curve, and is therefore smaller in magnitude than Δv_1. From the standpoint of a low reference point, the marginal disutility associated with an invasive procedure is valued as a foregone gain, and is thus perceived as less bad.

3 Mathematical Exposition

Although Figure 2 motivates the result, it is possible to prove that Δv_1 will always represent a larger subjective loss than Δv_2 or Δv_3. We use the following lemma, whose proof is elementary.

Lemma 1

If f is a concave function over some interval of real numbers with $f(0) = 0$, then

$$f(x + y) \leq f(x) + f(y)$$

whenever x, y and $x + y$ are in the domain of f, and

$$f(x - y) \geq f(x) - f(y)$$

whenever x, y and $x + y$ are in the domain of f.

We suppose a prospect theory value function of the form

$$v(x) = \begin{cases} v^+(x) & (x \geq 0) \\ -v^-(-x) & (x \leq 0) \end{cases}$$

where v^+,v^- are increasing concave functions over the nonnegative reals with $v^+(0) = v^-(0) = 0$. We assume $v^+(x) \leq v^-(x)$ for all x, in accord with the loss aversion principle.

Let x_0 be the subject's status quo health state, and $x_c = x_0 - C$ be the subject's status quo health state together with some additional intervention such as colonoscopy, where $C > 0$. We consider the three reference points mentioned above, namely $R_1 = x_0$ (the base case), $R_2 = x_0 + D$ (right-shifted reference point) and $R_3 = x_0 - D$ (left-shifted reference point). In the left-shifted case, we

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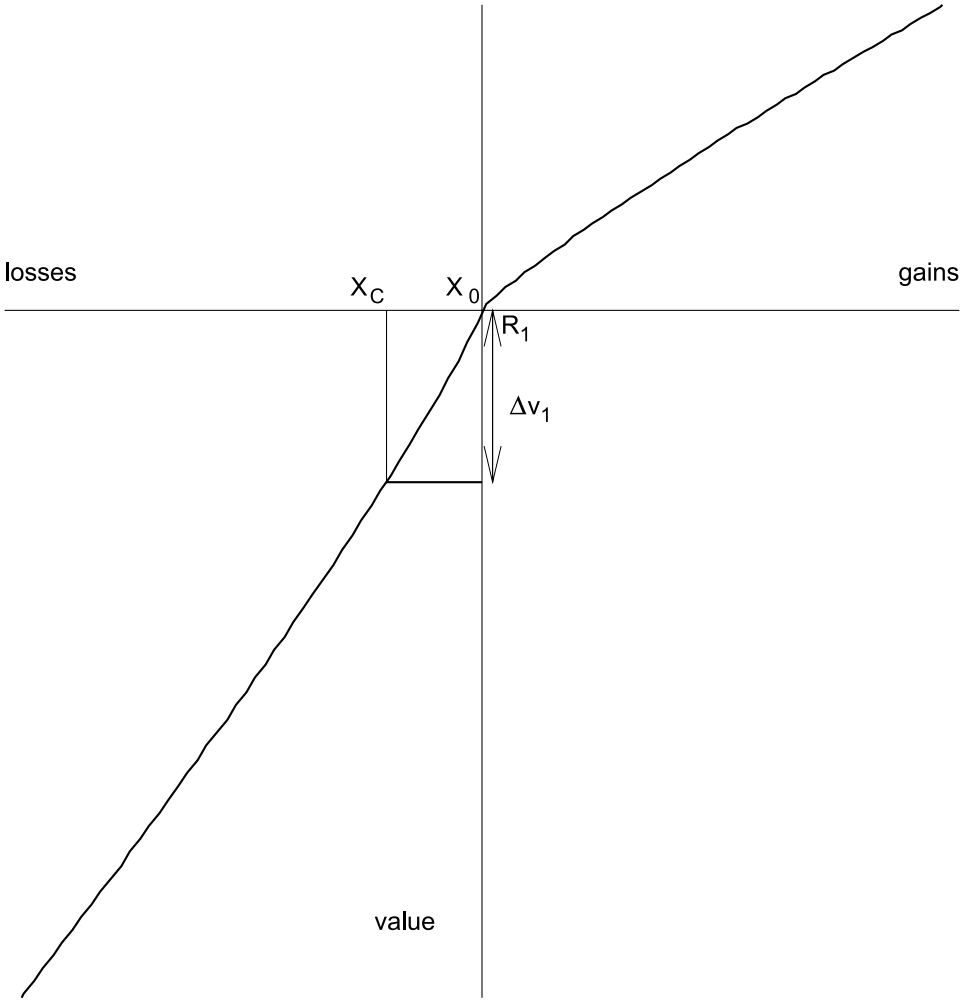

Figure 1: Graphical depiction of PT value function

assume the left shift D exceeds the decrement C due to intervention. The corresponding decrements in value are

$$\Delta v_i = v(x_c - R_i) - v(x_0 - R_i) \quad i = 1, 2, 3$$

Because $x_c < x_0$, these are all negative quantities.

Proposition 1 (Right-shifted reference point)

The decrement in value after a right shift in the reference point is less negative than the original decrement in value, that is,

$$\Delta v_2 \geq \Delta v_1$$

Proof: Note that we have

$$\begin{aligned} \Delta v_1 &= v(x_c - R_1) - v(x_0 - R_1) \\ &= v(x_0 - C - x_0) - v(x_0 - x_0) \\ &= v(-C) - v(0) = v(-C) = -v^-(C) \end{aligned}$$

$$\begin{aligned} \Delta v_2 &= v(x_c - R_2) - v(x_0 - R_2) \\ &= v(x_0 - C - x_0 - D) - v(x_0 - x_0 - D) \\ &= v(-C - D) - v(-D) \\ &= -v^-(C + D) + v^-(D) \end{aligned}$$

Therefore, we have

$$\Delta v_2 \geq \Delta v_1 \iff -v^-(C + D) + v^-(D) \geq -v^-(C)$$

But the last inequality is true by the concavity of v^- and the first inequality in Lemma 1. QED.

Proposition 2 (Left-shifted reference point)

The decrement in value after a left shift in the reference point is less negative than the original decrement in value, that is,

$$\Delta v_3 \geq \Delta v_1$$

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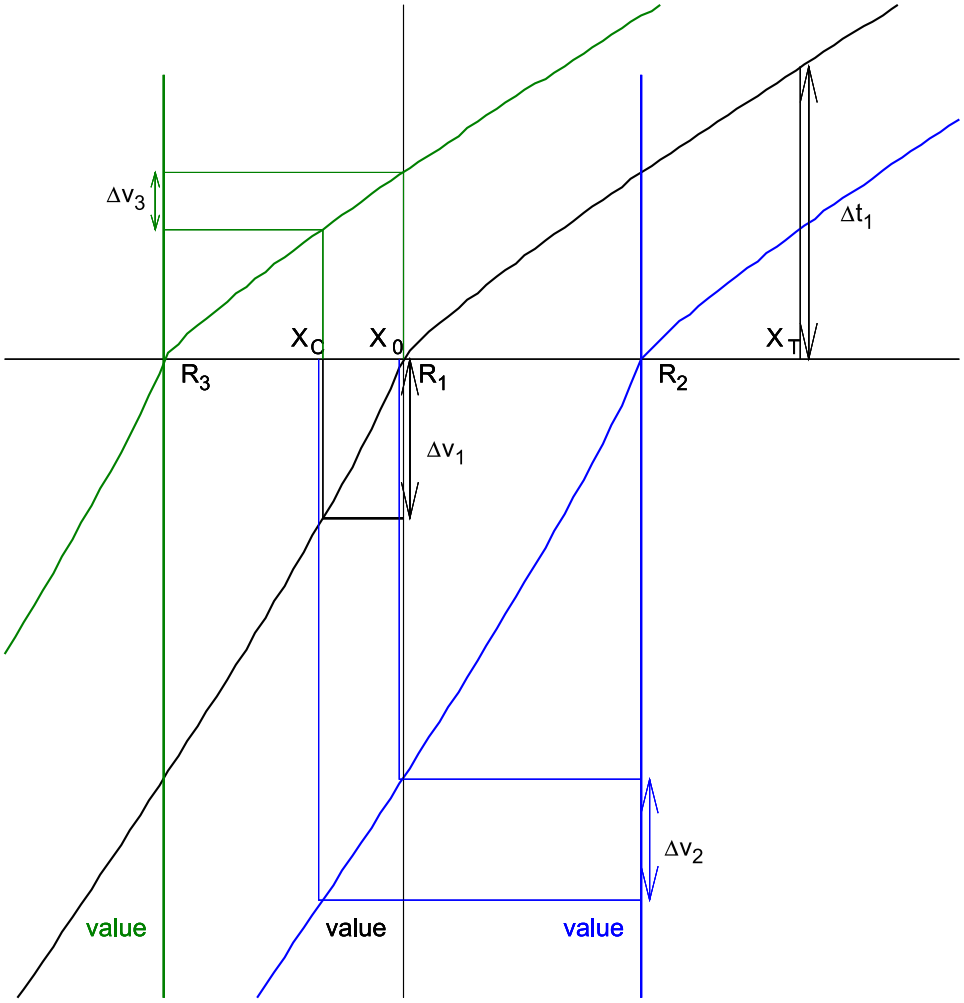

Figure 2: Graphical depiction of PT value functions with left and right shifted reference points

Proof: We have

$$\begin{aligned}\Delta v_3 &= v(x_c - R_3) - v(x_0 - R_3) \\ &= v(x_0 - C - x_0 + D) - v(x_0 - x_0 + D) \\ &= v(D - C) - v(D) \\ &= v^+(D - C) - v^+(D)\end{aligned}$$

where we have used the assumption that D exceeds C, so that $D - C > 0$. Then using $\Delta v_1 = -v^-(C)$, we have

$$\Delta v_3 \geq \Delta v_1 \iff v^+(D - C) - v^+(D) \geq -v^-(C)$$

To demonstrate the latter inequality, note that, by the loss aversion principle,

$$-v^+(C) \geq -v^-(C)$$

By the concavity of v^+ and the second inequality in Lemma 1,

$$v^+(D - C) - v^+(D) \geq -v^+(C)$$

Therefore, by transitivity,

$$v^+(D - C) - v^+(D) \geq -v^-(C)$$

so $\Delta v_3 \geq \Delta v_1$. QED.

4 Examples

As shown above, shifts of reference point, either to the right of baseline health or to the left of baseline health plus the invasive procedure, will shrink the disutility associated with the invasive procedure. If the invasive procedure is a recommended preventative screening test, such as colonoscopy, decreasing its disutility could be an important public health goal, if decisions to undergo

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screening are related to the perceived disutility of the procedure. How might potential screening recipients be induced to view their decision from either of these shifted reference points? Preliminary work with prostate cancer patients has suggested mechanisms which may motivate each of these valuable reference point shifts.

When a decision maker reflects upon his future health as he ages, he may recognize that it is likely to worsen naturally over the course of his life. From his current vantage point, then, this future health state can appear to be a relative loss. In this situation, it is as if the decision maker is examining the future focal health state (X_0) from a reference point (current health) that is significantly higher, such as R_2. When he focuses on his future health as a decrement in functioning, the additional disutility of an invasive procedure (Δv_2) is made smaller. This experience of "diminishing marginal loss" was reported in focus groups with prostate cancer patients through statements like

> "Ten years from now. ...if I'm fifty-five, sixty...I'm at the end of, as they so call say, at the end of your rainbow. Ain't too many people going to be hitting a hundred. If you are, are you going to be functional? I'm just being real ... Most elderly people, they need assistance. Ain't too many walking on their own, taking care of themselves. So hey, I would go with that longevity (and have treatment)." (Goldberg & Schwartz, 2007)

Conversely, when a decision maker reflects about difficult past experiences, she may recognize that undergoing the invasive procedure, though unpleasant, is still better than the past state - if she handled the past state, she knows she can handle the procedure. From this vantage point (R_3), even the prospect of the procedure (X_c) is an improvement in comparison to past experiences, and treated like a foregone gain in utility rather than an additional loss. Thus, when she uses her past experience as her reference point, the disutility of the invasive procedure (Δv_3) is again made smaller. This experience of "resiliency" was also reported in focus groups with men at high risk for prostate cancer in interactions like:

> "P1: I'd have surgery, I'd get it out."
>
> "F: ... Even though you're going to live with these side effects."
>
> "P1: Yeah, I mean, I was partially paralyzed in my left hand, three and a half years, I had nerve damage really bad. So I mean... I've been through some rough times, so I mean ="
>
> "P2: You live with it."
>
> "P1: Yeah, I'd have the surgery." (Goldberg & Schwartz, 2007)

5 Other Outcomes of the Screening Decision: Potential Benefit

If decision makers assume a shifted reference point in evaluating the relatively certain unpleasant experience of an invasive procedure, it is also reasonable to ask what the impact of the new reference point might be on their evaluation of other outcomes that should also motivate the decision to accept or reject the procedure. For simplicity, we assume that the primary benefit of a screening test is that it provides a small probability of resulting in an early detection of a treatable medical condition, and thus leads to treatment that provides a benefit that would not have been realized without the test. For example, a colonoscopy or pap smear that detects precancerous tissue may result in the patient receiving effective treatment that prevents the development of cancer, and thus meaningfully improves their quantity and quality of future life; this assumption is generally the rationale for recommendations of screening tests (e.g., see U.S. Preventive Services Task Force, 2003).

It is possible that different reference points may be applied to the evaluation of the utility of the test itself and to the evaluation of its potential benefit. If this is the case, and reflection on past or future experiences can be used to shift the reference point for the evaluation of the test itself without shifting the reference point for evaluation of the benefit, the propositions above predict that patients with such a reference point constellation ought to be relatively more likely to accept testing (because their disutility for the test is reduced while their appreciation of the potential benefit is unchanged).

It is perhaps more likely, however, that the new (shifted) reference point is applied to both the evaluation of the test and the evaluation of the potential benefit, shown as X_T in Figure 2. In the case of a right-shifted reference point (e.g. R_2), the benefit will always be evaluated more positively than in the base case, because one portion (from X_0 to R_2) will now be evaluated on the loss curve, which is steeper than the corresponding gain curve, and the remaining portion (from R_2 to X_T) will be evaluated on a steeper portion of the gain curve. That is, when the reference point is shifted to the right, the test is subjectively less unpleasant and the potential benefit is subjectively greater, which predicts a greater preference for the test. This result is independent of the probability of the benefit, but does assume that the reference point shift is not so extreme that R_2 falls to the right of X_T; that is, decision makers must consider the potential benefit of a true positive screen to be greater than their anticipated natural loss of functioning due to age. For screening tests intended to prevent diseases associated with high mortality and morbidity, like colorectal or cervical cancer, we believe these are reasonable (and testable) assumptions.

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In the case of a left-shifted reference point (e.g. R_3), however, the conditions under which a higher expected utility for the test would be perceived require considerably stronger assumptions that have no a priori justification. These conditions are dependent on the probability of benefit and the relative changes in the valuation of the test disutility and potential benefit.

6 Other outcomes of the screening decision: Potential harm

For simplicity, we have also assumed that the disutility of the medical procedure is completely characterized by X_c; that is, we treat the procedure's outcome as certain. In practice, of course, invasive tests often have small but significant risks; for example, the risk of a perforated colon during a colonoscopy has been recently reported to be 0.2-0.4% in purely diagnostic procedures, and 0.3-1.0% when polyps are removed during the procedure (Bonheur & Korelitz, 2006). As with the evaluation of X_c, a right-shifted reference point will diminish the subjective disutility associated with other potential negative outcomes, and the predicted greater willingness to accept the test should persist, independent of the probability of the potential negative outcomes.

A left-shifted reference point, however, only unconditionally attenuates the disutility when the new reference point is shifted to the left of the potential negative outcome, and few people are likely to have a salient referent that is worse than bowel perforation (which can constitute a surgical emergency). Accordingly, the impact of shifting the reference point to the left is likely to be dependent on the likelihood of potential negative outcomes and the associated decision weights.

7 Discussion

The prospect theory value function implies two ways that changes in reference points can result in a better evaluation of the anticipated experience of a potentially unpleasant invasive medical procedure: through drawing attention to future disability or through drawing attention to past disability. People who have already committed to the invasive procedure may engage in this sort of hedonic editing to reduce post-decision conflict about their choice; such editing operations have been posited in the past for financial decisions (Thaler & Johnson, 1990).

Perhaps more importantly from a public health standpoint, interventions that encourage people to change their reference points in these ways may increase the likelihood of a prospective patient committing to, for example, preventative health screenings. In particular, focus on future disability (the right-shifted reference point), has an impact on prospective decision that remains even when considering changes in the evaluation of the uncertain benefit of the test or potential uncertain risks of the test.

Of the two approaches, focus on future disability is also perhaps more widely applicable as an intervention strategy, as declining health with age is likely to be a universal and universally understood phenomenon. In addition, people seem to be quite capable of making influential comparisons to imagined (counterfactual) states, and this skill ought to extend to imagined future ("antefactual") states (Kahneman & Miller, 1986; Roese & Olson, 1995). In contrast, people who do not have signficantly distressing past experiences may not be moved by appeals to resiliency.

In effect, the reference point shift induces a contrast effect in which smaller losses are discounted in the new context which evokes larger losses (Thaler & Johnson, 1990; Tversky & Griffin, 1997). Such contrast effects have been observed with past experiences of physical pain (Dar, Ariely, & Frenk, 1995) as well as in the evaluation of health-related quality of life (Ubel, Loewenstein, & Jepson, 2003), but have not, to our knowledge, been derived for health care decision making from prospect theory. We would expect this contrast effect to operate alongside (and independently of) any message framing effects associated with the description of test outcomes.

It remains for empirical investigation to discover the extent to which such an approach is effective in changing valuations, individual differences that may moderate that effectiveness, and the impact of using a combined appeal to both reference points. Because relatively little is known about the number of reference points people use simultaneously or in rapid sequence, or how judgments from multiple reference points are combined or negotiated, there is much work to do.

References

Apanovitch, A. M., McCarthy, D., Salovey, P. (2003). Using message framing to motivate HIV testing among low-income, ethnic minority women. *Health Psychology, 22(1),* 60–67.

Bonheur, J. L. & Korelitz, B. I. (2006). Colonoscopy. *eMedicine* [online reference], Updated 2 August 2006, accessed 30 November 2007.

Dar, R., Ariely, D., & Frenk, H. (1995). The effect of past-injury on pain threshold and tolerance. *Pain, 60(2),* 189–193.

Finney, L. J. & Iannotti, R. J. (2002). Message framing and mammography screening: A theory-driven intervention. *Behavioral Medicine, 28,* 5–14.

Goldberg, J. & Schwartz, A. (2007). *Experience tips*

https://doi.org/10.1017/S1930297500001510 Published online by Cambridge University Press

the balance: A qualitative study of African-American men's decisions about prostate cancer. Manuscript submitted for publication.

Kahneman, D. & Miller, D. T. (1986). Norm theory: Comparing reality to its alternatives. *Psychological Review, 93(2),* 136–153.

Kahneman, D. & Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica, 47,* 263–291.

Moxey, A., O'Connell, D., McGettigan, P., & Henry, D. (2003). Describing treatment effects to patients: How they are expressed makes a difference. *Journal of General Internal Medicine, 18,* 948–959.

Rivers, S. E., Salovey, P., Pizarro, D. A, Pizaaro, J., & Schneider, T. R. (2005). Message framing and pap test utilization among women attending a community health clinic. *Journal of Health Psychology, 10(1),* 65–77.

Roese, N. J. & Olson, J. M. (1995). *What might have been : the social psychology of counterfactual thinking*. Mahwah, N.J., Lawrence Erlbaum Associates.

Rothman, A. J., Bartels, R. D., Wlaschin, J., & Salovey, P. (2006). The strategic use of gain- and loss-framed messages to promote healthy behavior: How theory can inform practice. *Journal of Communication, 56,* S202–S220.

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin, 121(1),* 3–19.

Thaler, R. H. & Johnson, E. J. (1990). Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice. *Management Science, 36(6)*, 643–660.

Tversky, A. & Griffin. (1997). Endowment and contrast in judgments of well-being. In Goldstein, W.M. & Hogarth, R. M. (eds.) *Research on Judgment and Decision Making: Currents, Connections, and Controversies*. Cambridge: Cambridge University Press, 411–428.

Tversky, A. & Kahneman, D. (2002). Advances in prospect theory: Cumulative representations of uncertainty. *Journal of Risk and Uncertainty, 5(4),* 297–323.

Ubel, P. A., Loewenstein, G., & Jepson, C. (2003). Whose quality of life? A commentary exploring discrepancies between health state evaluations of patients and the general public. *Quality of Life Research, 12(6),* 599–607.

U.S. Preventive Services Task Force Ratings: Strength of Recommendations and Quality of Evidence. (2003). *Guide to Clinical Preventive Services, Third Edition: Periodic Updates, 2000-2003*. Agency for Healthcare Research and Quality, Rockville, MD. http://www.ahrq.gov/clinic/3rduspstf/ratings.htm, accessed 30 November 2007.