Acceptable losses: The debatable origins of loss aversion

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Abstract

It is often claimed that negative events carry a larger weight than positive events. Loss aversion is the manifestation of this argument in monetary outcomes. In this review we examine early studies of the utility function of gains and losses, and in particular the original evidence for loss aversion reported by Kahneman and Tversky (1979). We suggest that loss aversion proponents have over-interpreted these findings. Specifically, early studies of utility functions have shown that while very large losses are overweighted, smaller losses are often not. Also, the findings of some of these studies have been systematically misrepresented to reflect loss aversion though they did not find it. These findings shed light both on the inability of modern studies to reproduce loss aversion as well as a second literature arguing strongly for it.

Keywords reward, punishment, loss aversion, negativity bias, utility

"*Pain is more dear than pleasure*" (Butler, 1822)

Introduction

It is often surmised that across a wide set of domains negative events are more influential than positive ones (see reviews in Cason, 1930; Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Rozin & Royzman, 2001). This echoes earlier claims of philosophers and scientists for an emotional asymmetry between positive and negative events (Smith, 1759; Schopenhauer, 1859; Edgeworth, 1877; Williams, 1922; Cason, 1930). For instance, Francis Ysidro Edgeworth indicated that "minus pain is sweeter than plus pleasure" (Edgeworth, 1877). Naturally, though, this assumption is quite difficult to test empirically since negative and positive events are often qualitatively different (e.g., an illness is not qualitatively similar to a shot of good health). Loss aversion is the tighter and more easily tested hypothesis that outcomes framed as losses carry more subjective weight than outcomes framed as gains (Kahneman & Tversky, 1979). Hence, empirical tests of loss aversion are often the pinnacle of the literature arguing for a negativity bias (Baumeister et al., 2001; Rozin & Royzman, 2001). Indeed, Kahneman (2011) has suggested that "the concept of loss aversion is certainly the most significant contribution of psychology to behavioral economics" (Kahneman, 2011, p. 300). Still, recent studies have shown that loss aversion does not emerge for small to moderate losses (see reviews in Yechiam & Hochman, 2013; Gal & Rucker, In press), inconsistently with the argument that it represents a general effect. In the current paper we review the empirical background that led Kahneman and Tversky (1979) to propose the general notion of loss

aversion. Based on the reviewed evidence, we suggest that much of the early evidence for this phenomena had been over-interpreted.

Kahneman and Tversky are probably well placed as the fathers of the concept of loss aversion not only because they proposed the term, but also because of its parsimonious and clear operationalization. First of all, they suggested that "most people find symmetric bets of the form (x, .50; -x, .50) distinctly unattractive" (p. 279), meaning that people typically reject 50:50 lotteries because "losses loom larger than gains" (p. 279). Secondly, they proposed that given a choice between different 50:50 lotteries (x, .50; -x, .50 vs. y, .50; -y, .50), people pick the lottery with the smaller payoffs, since this minimizes the size of potential losses.[1]

The concept of loss aversion is central to Kahneman and Tversky's prospect theory and its distinction from expected utility theory (Bernoulli, (1738 [1954]); von Neumann & Morgenstern, 1944) and subjective utility theory (e.g., Friedman & Savage, 1948). In contrast to what might be assumed based on expected utility theory, it implies that people's reference point for sizing up different amounts is based on their subjective impression of the status quo and not on the objective zero. Moreover, prospect theory goes beyond previous empirical models based on subjective expected utility theory (e.g., Edwards, 1954) in that the sign of the difference from the reference point also determines the outcomes' subjective weight, with losses being given about twice the weight of respective gains (some authors have argued for larger ratios of around five-fold; e.g., Fishburn & Kochenberger, 1979; Baumeister et al., 2001).

[1] For instance, when selecting between a 50:50 bet for $10 or -$10 and a similar bet for $20 or -$20 people presumably pick the former option.

Prospect theory's loss aversion is also quite different from the much-recognized notion of risk aversion in classical finance (i.e., avoidance of high variance outcomes; Markowitz, 1952; Pratt, 1964; Sharpe, 1964). Most proponents of risk aversion assumed that individuals are generally risk averse (e.g., Markowitz 1952), while some postulated that each individual has a preferred (or ideal) risk level and that risk aversion only emerges for options above one's preferred risk level (Pruitt, 1962; Coombs, 1964). Neither of these accounts, however, posits a special role to the sign of the payoff (gains or losses).

Finally, loss aversion also diverges from the notion of minimal requirements, which suggests that overweighting of losses only emerges for large losses below a certain cutoff point (Tversky, 1972; Raiffa, 1982; Kacelnik & Bateson, 1997; Wang & Johnson, 2012). The notion of minimal requirements is often explained by the idea that below certain cutoff points negative outcomes can carry a future cost that is heavier than the direct immediate penalty, such the chance of future economic ruin (Raiffa, 1982). Hence, the rational choice is to avoid outcomes below these cutoff points. For example, student participants in Wang and Johnson (2012) attached high subjective weight to a salary drop below the point implying that they were not able to pay rent in their university town. The notion of minimal requirements implies that the cutoff point from which losses begin to be overweighted is highly dependent on individuals' current life conditions. Loss aversion therefore appears to be more parsimonious as it does not need an additional free parameter for where losses begin to be overweighted; yet this comes with an empirical burden: the assumption (under loss aversion) that the increased weight to losses is robust for small outcomes as well.

Loss aversion has been used to account for several economic phenomena that are not directly explained by neoclassical economic models (see review in Camerer, 2005). Examples, presented in Table 1, include inequality aversion (Walster, Walster, & Berscheid, 1978), the endowment effect (Thaler, 1980; Kahneman et al., 1990), and the status quo bias (Samuelson & Zeckhauser, 1988). It has also been used to explain important phenomena in finance, such as the equity premium puzzle (the anomalously higher historical real returns of stocks over government bonds; Grossman & Shiller, 1981; Benartzi & Thaler, 1995) and the disposition effect (Shefrin & Statman, 1985).

Still, in the last ten years some studies revisiting the original paradigm of Kahneman and Tversky (1979) using 50:50 lotteries, could not reliably find loss aversion in the form predicted by Kahneman and Tversky (1979), namely avoidance of these lotteries (see review in Yechiam & Hochman, 2013; and see also Ert & Erev, 2013; Walasek & Stewart, 2015; though see exceptions in Abdellaoui, Bleichrodt, & Paraschiv, 2007; Rabin & Weizsäcker, 2009). This has led to suggestions that loss aversion may be observed only in specific contexts (Ert & Erev, 2013; Gal & Rucker, In press) or even that it does not exist as an independent phenomenon (Yechiam & Hochman, 2013). Moreover, researchers have found a host of other asymmetries between gains and losses that occur simultaneously with no loss aversion. These include increases in autonomic arousal and midfrontal cortical activation when losing (Hochman & Yechiam, 2011; Gehring & Willoughby, 2002; Yeung & Sanfey, 2004), as well as increased deliberation time (Xue et al., 2009; Yechiam & Hochman, 2013), expected value maximization (Yechiam & Hochman, 2013a), and exploration of the available alternatives (Lejarraga & Hertwig, & Gonzalez, 2012; Lejarraga & Hertwig, 2017). All of these asymmetries were

found to emerge in task conditions where individuals did not overweight losses compared to gains, which further suggests that the effect of losses on the human mind cannot be singly captured by loss aversion. This new debate on loss aversion raises interesting questions with respect to its empirical origins.

The goal of the present work is to clarify how the construct of loss aversion was originally formed by Kahneman and Tversky (1979) based on the existing evidence at the time. We begin by examining the claims made by Kahneman and Tversky (1979), and follow by reviewing the findings of prior studies mentioned in Kahneman and Tversky's (1979) seminal study. Finally, we examine other evidence for this phenomenon existing before 1979. A review of these prior studies suggests that the many of the findings reviewed by Kahneman and Tversky (1979) do not actually directly indicate loss aversion in the way it was envisioned in prospect theory. Instead, what appears to be a robust finding is an aversion to high stakes losses, and gain/loss neutrality for small to moderate losses.

Kahneman and Tversky (1979)

Kahneman and Tversky's (1979) prospect theory highlighted important empirical regularities inconsistent with the predictions of von Neumann and Morgenstern's (1944) expected utility theory and its variants. Some of the main empirical regularities identified were the reflection effect (people's tendency to take risk in the loss domain while avoiding it in the gain domain), the framing effect (the ease of creating these domains by differences in wording), overweighting small probabilities and underweighting moderate to large probabilities, and loss aversion. All of these regularities except for loss aversion

were demonstrated empirically by Kahneman and Tversky (1979) in several experiments. Exclusively, though, Kahneman and Tversky (1979) had treated loss aversion as a stylized fact.

Only in 1992 did Tversky and Kahneman (1992) and Redelmeier and Tversky (1992) start to empirically investigate loss aversion, and when they did, they used either very large amounts (Redelmeier & Tversky, 1992) or the so called “list method” in which one chooses between lotteries with changing amounts up until choices switch from one alternative to the other (Tversky & Kahneman, 1992). This usage of high amounts would come to characterize most of the literature later arguing for loss aversion (e.g., Redelmeier & Tversky, 1992; Abdellaoui et al., 2007; Rabin & Weizsäcker, 2009) as would be the usage of decisions that are not incentivized (i.e., hypothetical; as discussed below).

Still, already in their 1979 paper, Kahneman and Tversky (1979) strongly argued for loss aversion even though at the time they had not reported any experiments to support it. By indicating that this was a robust finding in earlier research, Kahneman and Tversky (1979) were able to rely upon it as a stylized fact. They begin their discussion on losses by stating that “a salient characteristic of attitudes to changes in welfare is that losses loom larger than gains” (p. 279), which suggests that this stylized fact is based on earlier findings. They then follow with the (much cited) sentence that “the aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount [17]” (p. 279). Most people who cite this sentence do so without the end quote of Galenter and Pliner (1974).[2] Galenter and Pliner

[2] As evidenced in a Google Scholar search from July 2017. From 105 available full texts who cited the sentence in whole only four cited the reference.

(1974) is therefore the first empirical study used to support the notion of loss aversion. Kahneman and Tversky (1979) seem to base their next sentence on this particular paper, stating that: “Indeed, most people find symmetric bets of the form (x, .50; -x, .50) distinctly unattractive” (p. 279).

Culminating their discussion on loss aversion, Kahneman and Tversky (1979) then cite another paper. They argue that “the main properties ascribed to the value function have been observed in a detailed analysis of von Neumann-Morgenstern utility functions for changes of wealth [14].” (p. 281). The citation refers to Fishburn and Kochenberger’s forthcoming paper (at the time; published 1979). Fishburn and Kochenberger’s (1979) study reviews data of five other papers (Grayson, 1960; Green, 1963; Swalm, 1966; Halter & Dean, 1971; Barnes & Reinmuth, 1976) also cited by Kahneman and Tversky (1979). Summing up all of these findings, Kahneman and Tversky (1979) argue that “with a single exception, utility functions were considerably steeper for losses than for gains.” (p. 281). The “single exception” refers to a single participant who was reported not to show loss aversion, while the remaining one apparently did. A natural step in chasing down the origins of loss aversion is to examine these earlier works.

The presumed origins of loss aversion

Galenter and Pliner (1974)

Galenter and Pliner (1974) examined the sensation following monetary outcomes, or in their words “the degree of happiness money would bring” (p. 65). Their approach was based on the then recently discovered cross-modality matching technique (Stevens &

Marks, 1965). Participants first gave five loudness judgements for each of fifteen different tones varying in amplitude. This was used as a control index. Next, they were asked to describe in a similar vein their “happiness index” for a list of monetary gains (in Experiment 1) and monetary losses (in Experiment 2), as follows:

“You will put the earphones on again and will hear a tone of a certain loudness. This will be the comparison tone. We will assume that receiving $90.00 is analogous to the loudness of this comparison tone. Then, I will mention other amounts of money and you will adjust the tone with this device [potentiometer shown] so that its loudness is analogous to how happy you would feel in receiving those amounts of money. For example, let us say that receiving $50.00 would make you 1/2 as happy as receiving $90.00, then you would set the tone so that it would sound 1/2 as loud as the comparison tone. Or, for example, if receiving $150.00 would make you three times as happy as receiving $90.00, you should set the tone so that it sounds three times as loud as the comparison tone.” (p. 67).

The two experiments enabled comparing the steepness of the respective psycho-physical functions for gains and losses. Consistent with the convention of studies in perception at the time (and ours as well), the experiments only involved few subjects, amounting to seven in each. The results revealed a similarity between the curvature of the happiness index for the gain and loss domains. Summing up their findings, Galenter and Pliner (1974) reported as follows: “We now turn to the question of the possible asymmetry of the positive and negative limbs of the utility function. On the basis of

intuition and anecdote, one would expect the negative limb of the utility function to decrease more sharply than the positive limb increases… what we have observed if anything is an asymmetry of much less magnitude than would have been expected… the curvature of the function does not change in going from positive to negative" (p. 75).

Thus, our search for the historical foundations of loss aversion turns into a dead end on this particular branch: Galenter and Pliner (1974) did not observe such an asymmetry; and their study was quoted erroneously.

Fishburn and Kochenberger's review (1979)

Fishburn and Kochenberger (1979) also assessed the potential asymmetry in the utility function for gains and losses, though based on decisions rather than sensations. Their dataset combined five earlier studies as noted above (Grayson, 1960; Green, 1963; Swalm, 1966; Halter & Dean, 1971; Barnes & Reinmuth, 1976). All of these studies used hypothetical decisions. While it is clear that such decisions may deviate from one's course of action with actual incentives, later studies have revealed considerable similarities between people's level of risk taking under incentivized and non-incentivized conditions (e.g., Camerer, 1989; Kachelmeier & Shehata, 1992), suggesting that these results are a reasonable way to predict people's responses to actual losses.[3]

The studies reviewed by Fishburn and Kochenberger (1979) involved choices between a lottery and a constant amount, and mapped objective payoffs to subjective utilities using a simple formula based on the point of indifference between the lottery and

[3] Also, it is extremely difficult to directly investigate the effect of large losses in an ethical fashion using actual incentives.

the constant amount. For example, if a participant is indifferent between a lottery of 10% to get 100 and a sure amount of 8 then it is assumed that:

$$U(8) = 0.10 * U(100) \tag{1}$$

Where U is the subjective utility function. If we set an arbitrary upper bound for the utility level, e.g., that U(100) equals one, then we can calculate the relative utilities of other amounts (e.g., U(8) = 0.1).

Fishburn and Kochenberger divided the payoff space into two parts based on a "target point" which was defined as "point t on the abscissa at which something unusual happens to the individual's utility function" (p. 504). Their rationale for this was that something unusual is expected to happen when moving from the loss domain to the gain domain; hence if something unusual happens in the function, it is in the point where the domain changes. Fishburn and Kochenberger (1979) scanned the data, and for each individual participant decided on a target point based on this criterion. Next, "the original data were transformed linearly so that the transformed target point and its utility were both zero." (p. 505). In other words, a constant was added to all objective payoffs so that the target point was moved to zero, and the utility at this point was set to zero as well. Although in most cases (77% of the analyzed subjects) Fishburn and Kochenberger's (1979) designated target point was the objective zero (see Table 2), there were a few cases were it was not. This is an obviously problematic way of looking into the data since it uses the dependent measure to calculate the independent one (see Vul, Harris, Winkielman, & Pashler, 2009). In this manner, Fishburn and Kochenberger (1979) found that the gradient of the above-target function was steeper than that of the below-target

function, with a median below-to-above slope ratio of approximately 4.8, about twice the ratio reported by Tversky and Kahneman (1992).

We next move into the original studies which were modeled by Fishburn and Kochenberger (1979). Details concerning the methodology of the five studies appear in Table 2. All in all, the studies examined 30 participants. We first present the methodology of Swalm's (1966) study since it has the largest sample size. The participants in this study were executives from various corporations who were interviewed concerning their corporate decisions, namely decisions involving their organization (and not themselves personally). The first line of questions was aimed to find a "planning horizon" defined as twice the maximum amount that the person recommends spending in any one year. This was used to establish an upper limit for the decision problems that followed. The second line of questions concerned choices between risky outcomes with 50:50 odds and fixed outcomes. The questions were framed in a realistic fashion. For instance, if a worker's planning horizon is $1 million, then he might be asked the following question:

"Suppose your company is being sued for patent infringement. Your lawyer's best judgement is that your chances of winning the suit are 50-50; if you win, you will lose nothing, but if you lose, it will cost the company $1,000,000. Your opponent has offered to settle out of court for $200,000. Would you fight or settle?" (p. 131).

Participants could indicate that they prefer to fight or to settle, or that they are indifferent between the two options. Next, the participants were asked variants of this question, with

the fixed amount changed in order to get to the point where the participant is indifferent between the options. For example, if the participant picked the “fight” option, the cost of settling was slowly decreased in subsequent questions, and vice versa. In yet another line of questions, one of the amounts was missing and participants had to fill it up. For instance, in the above example a participant could be asked at what certain outcome for settling out of court would s/he be indifferent between fighting and settling.

In Grayson (1960), Green (1963), and Barnes and Reinmuth (1976) the methodology was similar, though questions were identical for different participants (and not tailored based on their spending plans). For example, in Grayson (1960) the participants were oil and gas drillers and decisions were couched as company drilling dilemmas. For instance, a participant had to select between not drilling and getting zero to drilling where drilling provides a 25% chance of finding oil worth of $200,000 and otherwise losing $20,000 due to the cost of the drill.

The results of the 13 individuals examined by Swalm (see Figure 1) appear at first glance to be consistent with an asymmetric utility function implying overweighting of losses compared to gains (i.e., loss aversion). Notice, however, that amounts are in the thousands such that the smallest amount used was set above $1000 and typically above $5000 because it was derived from the participant’s “planning horizon”. Moreover, for more than half of the participants the utility curve near the origin (marked in blue in Figure 1), which spans the two smallest gains and two smallest losses for each person, was linear. This deviates from the notion of loss aversion which implies that asymmetries should also be observed for small amounts as well.

A similar pattern is observed in Grayson's utility functions (See Figure 2).[4] The amounts used were also extreme high, with only one or two points below the $50,000 range. For the points above $100,000 the pattern seems to show a clear asymmetry between gains and losses consistent with loss aversion. However, for 2 / 9 participants (see figure) the utility curve for the points below 100,000 does not indicate loss aversion, and for 2 / 9 additional participants no loss aversion is observed for the few points below $50,000. Thus, it appears that in Grayson (1960) and Swalm (1966) almost all participants behaved as if they gave extreme losses more weight than corresponding gains, yet about half of them did not exhibit a similar asymmetry for the lower losses (e.g., below $50,000 in Grayson, 1960). This can be explained by the notion of a preferred level of risk (Coombs, 1964), with risk aversion emerging only for risks above a certain level of variance. In a utility function this kind of risk aversion would be naturally captured by higher subjective weights to extreme losses compared to respective gains.[5] Alternatively, the findings of Grayson (1960) and Swalm (1966) can be captured by the minimal requirements account. Losing more than $50,000 in Grayson (1960), for instance, could imply additional costs, such as not being able to pay company debts.

There also seem to be additional methodological problems in these studies involving potential demand effects. For example, Swalm (1966) elicited utilities for "about 100 executives" (p. 129) but modeled the results of only 13 non-randomly chosen cases (Fennema & Van Assen, 1999); likewise Green (1963) interviewed 16 individuals

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[4] The tenth data point is a repeated questioning of a participant (Bill Beard) and is not included; it shows a pattern similar to that of the top left pane.

[5] By contrast, in portfolio theory (Markowitz, 1952) this would be captured by symmetric weights to gains and losses and a risk premium – an additional cost for taking risk which increases as a function of the distance from the preferred risk level.

and presented the results of only four. No rationale is provided for the choice to present only some of the data in either of these studies.[6]

Also, as noted above, Fishburn and Kochenberger (1979) transformed the objective payoffs of some of the subjects based on a target point which was defined as "point t on the abscissa at which something unusual happens to the individual's utility function" (p. 505). This is particularly problematic for analyzing Green's (1963) data, shown on Figure 3. The curves appear to indicate loss aversion but the Y axis is placed at around 20% and not at zero. This point was selected as the target point in Fishburn and Kochenberger (1979), meaning that points below it were treated as losses. In reality, however, Green (1963) did not examine any losses, making any interpretation concerning loss aversion in this study speculative as it rests on the authors' subjective impression.

Loss aversion in other early studies of risk taking

In 1955 Davidson, Siegel, and Suppes conducted an experiment in which participants were presented with heads or tails bets which they could accept or refuse. Differently from the studies reviewed above, the choices were incentivized. If participants did not accept the bet, no money changed hands. If they did, they won or lost money based on an actual coin toss. Outcomes were in cents and ran up to a gain or loss of 50 cents. The results of 15 participants showed that utility curves for gains and losses were symmetric (see Figure 4 which is based on the raw data included in their paper), with a loss/gain utility ratio of 1.1 (far below than the 2.25 estimated by Tversky and Kahneman, 1992).

[6] The subsample presented in Swalm (1966) was also somewhat biased. Participants were initially collected from two populations: A single company referred to as "Company A" and a cross-industry population. All but one of the presented participants were from Company A.

The authors also re-analyzed an earlier dataset by Mosteller and Nogee (1951) involving bets for amounts ranging from -30 to 30 cents, and it too showed utility curves that were symmetric for gains and losses.

Lichtenstein (1965) similarly used incentivized bets and small amounts. Participants in her study were asked to propose bids (i.e., payments) for different lotteries. Each lottery had three gain and loss outcomes with varied probabilities based on fractions with a denominator of eight (e.g., 1/8, 1/8, 6/8; 1/8, 2/8, 5/8; etc.). Additionally, Lichtenstein (1965) studied four levels of variance (0.25, 1.00, 2.25, and 4.00). A random third of the participants' bids were played. Lichtenstein (1965) found that the 12 participants in her study preferred lotteries with lower variance. The mean willingness to pay for the low variance lotteries was -7 cents compared to -25 cents for the higher variance lotteries, a significant difference (though the statistical analyses are not fully detailed). Based on this finding Lichtenstein (1965) argued that "The preference for low V [variance] bets indicates that the utility curve for money is not symmetric in its extreme ranges; that is, that large losses appear larger than large wins." (p. 168). Thus, Lichtenstein (1965) interpreted her findings not as a general aversion to losses (which would include small losses and gains), but only as a tendency to overweight large losses relative to large gains.

Subsequent to this, Lichtenstein and her colleagues used other methods to examine the sensitivity to gains and losses. Slovic and Lichtenstein (1968) developed a regression-based approach to examine whether the participants' willingness to pay (WTP) for a certain lottery is predicted more strongly by the size of its gains or the size of its losses. Their results showed that size of losses predicted WTP more than sizes of

gains. This was interpreted by the authors as indicating that “potential losses exert more influence on a gamble’s attractiveness than potential gains of the same magnitude” (Slovic and Lichtenstein, 1968, p. 9). This statement is somewhat more ambiguous than that made by Lichtenstein (1965) and for a good reason: as long as the predictors are only gains and only losses, the fact that the size of losses is a better predictor implies that large losses affect choices more than large gains, though not so for smaller losses;[7] which is not consistent with loss aversion as stated later by Kahneman and Tversky (1979). Moreover, in a follow-up study Slovic (1969) found a reverse effect in hypothetical lotteries: Choices were better predicted by the gain amount than the loss amount. In the same study, he found no difference for incentivized lotteries in this respect.

Similar findings of no apparent loss aversion were observed in studies that used probabilities that are learned from experience (Katz, 1963; 1964; Myers & Suydam, 1964). For example, Katz (1964) examined a choice between predicting in which of two lightbulbs a flash of light would occur in the next trial. In both lightbulbs success was equally likely: in one success and failure led to a reward or a penalty of 1 chip; and in the other they led to a reward or a penalty of 2 chips, respectively. The experiment involved 100 trials, and at the end of it chips were redeemed at 25 cents per unit. This problem is equivalent to repeatedly selecting between a gamble producing +1 or -1 chips with equal odds and one producing +2 or -2 with equal odds. Loss aversion implies the a preference

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[7] Given equal distances between objective values in a gain and loss domain *a* and *b* for alternatives 1 and 2 (e.g., $a_1 = 1$, $a_2 = 10$; $b_1 = -1$, $b_2 = -10$) if one is more sensitive to the loss domain (e.g., the correlation between choices and *a* is higher than the respective correlation with *b*), then assuming a negative linear effect of losses this implies a stronger pull effect of large losses than large gains in terms of changes in standard deviations of choices, but a symmetric weaker effect for small losses. This can change if the references point is zero ($a_1 = 0$, $b_1 = 0$).

for the former option in order to avoid the larger loss of two chips. This, however, did not emerge: Participants chose the two options equally.

Summary and conclusions

Fishburn and Kochenberger (1979) and Kahneman and Tversky (1979) based their empirical claims for loss aversion on earlier examinations of utility functions in five studies. However, the utilities elicited in these studies were for high monetary amounts, with the smallest amounts being typically above $1,000. Furthermore, by adopting a simple linear and exponential models, they ignored what appears to be a symmetric utility for smaller magnitude gains and losses in about half of the participants, as indicated in Figures 1 and 2 (e.g. up to $50,000 in Grayson 1960). It is true that in most of the data points analyzed by Fishburn and Kochenberger (1979) there actually was a payoff asymmetry between gain and losses. Still, collapsing across these multiple points hides the points that seem critical to the interpretation of the findings as supporting loss aversion (i.e., smaller amounts), especially as compared to the notion of preferred risk level (Coombs, 1964) and the minimal requirements account, under which the increased weighting of losses compared to gains is limited to the case of large expenditures.

Additionally, the results of several studies seem to have been misrepresented by Fishburn and Kochenberger (1979) and Kahneman and Tversky (1979). Galenter and Pliner (1974) were wrongly cited as showing loss aversion, whereas in fact they did not observe an asymmetry in the pleasantness ratings of gains and losses. Likewise, in Green (1963) the results were argued to show loss aversion, even though this study did not involve any losses. Also, the objective outcomes for some of the participants in Grayson

(1960) were transformed by Fishburn and Kochenberger (1979) so as to better support a model assuming different curvatures for gains and losses (see Table 1). Finally, studies showing no loss aversion, or suggesting aversion to large losses were not cited in Fishburn and Kochenberger (1979) or in Kahneman and Tversky (1979). This includes Davidson et al. (1955) who used much smaller amounts running up to 50 cents and obtained symmetric utility curves for gains and losses, as well as the results of Mosteller and Nogee (1951), Lichtenstein (1965), Slovic (1969), and Katz's (1964) study of repeated choices.

In summary, the current review suggests that the literature concerning losses existing in and prior to Kanheman and Tversky (1979) has been overinterpreted by Kanheman and Tversky (1979) and in the subsequent literature. First of all, the preponderance of loss aversion (with all but one of the subjects being argued to show losss aversion) seems to have been exaggerated as this behavioral regularity was not observed in several studies, including studies that were cited as supporting loss aversion (Galenter & Pliner, 1974; Green, 1963). Secondly, loss aversion in estimated utility functions was only observed in studies focusing on very high amounts and not in studies of small amounts (e.g., Davidson et al., 1955). Thirdly, even in the studies focusing on high amounts reviewed by Fishburn and Kochenberger (1979) loss aversion was not observed for about half of the participants for the smallest amounts used, but only for higher amounts (Grayson, 1960; Swalm, 1966). These findings are difficult to reconcile using a "tilted scales" metaphor of losses being overweighted compared to gains; nevertheless they were over-interpreted to indicate a general asymmetry in the utility function for gains and losses.

Implications to modern studies of loss aversion

Importantly, there seems to be consistency in the debatable methodologies used to elicit loss aversion in these early investigations and in modern studies. Most prominently these methodologies include the usage of elevated amounts of money, often to an excess of $1000 losses (see review in Yechiam & Hochman, 2013). In a review of the literature Yechiam and Hochman (2013) have shown that modern studies of loss aversion seem to be binomially distributed into those who used small or moderate amounts (up to $100) and large amounts (above $500). The former typically find no loss aversion while the latter do. For example, Yechiam and Hochman (2013) reviewed 11 studies using decisions from description (i.e., where participants are given exact information regarding the probability of gaining and losing money). From these studies seven did not find loss aversion and all of them used loss/gain amounts of up to $100. Four did find loss aversion, and three of them used very high amounts (above $500 and typically higher). Thus, the usage of high amounts to produce loss aversion is maintained in modern studies.[8]

Proponents of loss aversion may argue that the asymmetric response to gains and losses is more distinct for large amounts since loss aversion gets larger as a function of the size of the loss. Furthermore, it could be argued that the fact that loss aversion is found only in high stakes serves as a validation of loss aversion because it shows that even when people care much about the outcome of their decision they are still biased.

[8] In a similar vein, Harinck, Van Dijk, Van Beest, and Mersmann (2007) examined the pleasantness level associated with gains and losses, and people's willingness to pay for lotteries involving gains and losses of different sizes. They only found increased unpleasantness compared pleasantness ratings in outcomes above 50 Euros, and similarly report loss aversion in willingness to pay for large outcomes only.

These statements may be true (or not) but in the author's view they reduce the loss aversion account into the minimal requirements account. Additionally, the findings of apparent loss aversion for high stakes could be due to a preferred risk level.[9] Using the term loss aversion and its formalization within prospect theory to account for such findings can lead to inappropriate predictions for small losses.

One might alternatively argue that the evidence for loss aversion for small amounts of money exists in studies of learning and performance. Indeed, quite early psychologists have shown that punishing incorrect responses is typically more effective than rewarding correct responses (e.g., Dodson, 1932; Penney & Lupton, 1961; Meyer & Offenbach, 1962; Costantini & Hoving, 1973). For example, in Costantini and Hoving's (1973) study of the development of response inhibition, children either received marbles for successful performance, or lost the same amount of marbles for unsuccessful performance. The loss condition was conducive to considerably better performance, leading the authors to assert that "The motivational effect of losing marbles is apparently greater than receiving them." (Costantini & Hoving, 1973; p. 492). Similar findings have since been found in many studies (e.g., Ganzach & Karshai, 1995; Bereby-Meyer & Erev, 1998; Andreoni, Dickinson, 2004; Pope & Schweitzer, 2011; Hossain & List, 2012; Anbarci, Arin, Okten, & Zenker, 2017) and were almost unanimously interpreted as the product of loss aversion. However, Costantini and Hoving's (1973) original explanation, which accounts for this set of findings, does not necessarily imply loss aversion, but

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[9] While the preferred risk level account is apparently not consistent with the findings showing risk seeking for losses and risk aversion for gains (i.e., the reflection effect; Kahnman & Tversky, 1979), these regularities are explained by other factors besides the sensitivity to variance (e.g., diminishing sensitivity to zero) which could affect choice behavior in addition to a one's preferred risk level. Supporting this view are findings of positive association between individuals' risk taking levels in a gain domain and a mixed domain with symmetric gains and losses demonstrating consistency in individuals' risk preferences independently of the losses involved (e.g., Yechiam & Ert, 2011).

instead suggests that losses increase the prioritization of the task and the respective allocation of effort to it. Consistent with this notion, losses were found to increase performance even in tasks in which fixed losses were incurred regardless of the participants' performance (see Yechiam & Hochman, 2013a; Yechiam, Retzer, Telpaz, & Hochman, 2015). This line of studies therefore does not imply loss aversion in an unequivocal manner. Also, it should be noted that the findings reviewed above do not contradict the notion that there is an asymmetry in the way people process gains and losses, just the particular way in which this asymmetry was implemented in prospect theory through the assumption of loss aversion.

Proponents of loss aversion often further raise the notion that this construct can explain a variety of empirical phenomena where individuals stray from the dictums of a purely rational model, as indicated in Table 1 (see e.g., Tversky & Kahneman, 1991; Camerer, 2005). One should note, though, that all of these phenomena have alternative explanations, and some that are probably as intuitive as loss aversion. For example, the endowment effect, sellers' tendency to assign higher prices to objects than buyers, can be explained by sellers' sensitivity to market prices, which are often higher than one's idiosyncratic prices (Weaver & Frederick, 2012). It can also be accounted for by the positive attributions granted upon an object due to its ownership (Morewedge & Giblin, 2015). Likewise, as noted above increased performance in tasks with losses (Costantini & Hoving, 1973), often attributed to loss aversion (e.g., Pope & Schweitzer, 2011) can be driven by the attentional investment brought about by losses (Yechiam & Hochman, 2013), which is independent from the subjective weighting of gains and losses. Increased attention to losses still implies that "losses loom larger" but it suggests that instead of

leading to a cognitive bias, losses actually have the reverse effect of increasing people's sensitivity to the incentive structure.

Loss aversion supporters could nevertheless argue that combined together, the alternative explanations to the empirical phenomena summarized in Table 1 are less parsimonious than the loss aversion account, and that neither of them covers all of the noted behavioral anomalies. Still, a counter-argument is that the definition of loss aversion also is slightly different when applied to some of these phenomena. For example, for goods (the endowment effect) no loss aversion is assumed for money, but only (or mostly) for the traded object. On the other hand, in studies of performance negative monetary amounts are argued to have higher utility than positive ones. Likewise, the explanation of the disposition effect implies that when an owned asset is losing, this is not considered as a loss, but only when it is realized (liquidated) it does. The current exercise suggests that in the attempt to use a parsimonious "scientific blanket" to cover many behavioral anomalies, the original proponents of loss aversion may have used an overly general framework, and one offering a rather pessimistic view of the human mind.

Compliance with Ethical Standards

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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Table 1: Well-known examples of empirical phenomena accounted for by loss aversion that are not directly implied by neoclassical economic models.

The effect	Description	Explanation by loss aversion	Alternative explanations
Inequality aversion (Walster et al., 1978)	Tendency to dislike unequal sharing of wealth	Sensitivity to others' loss is larger than to others' gain	Egalitarianism
Endowment effect (Kahneman et al., 1990)	Tendency of selling prices to exceed buying prices	Seller relinquishes an object	Sellers' sensitivity to market cues, ownership effect
Status quo effect (Samuelson & Zeckhauser, 1971)	Tendency to retain the status-quo	A change introduces deviation from the reference point, with losses looming larger	Effort reduction
Greater sensitivity to differences in the loss domain (Tversky & Kahneman, 1992)	The same difference is given more weight if viewed as a difference between two disadvantages than two advantages	The loss function is steeper than the gain function	Greater attention to losses
Increased performance with losses (Costantini & Hoving, 1979)	Increased performance in tasks where payoffs are framed as losses (from a prepaid amount) than as gains	Losses are given more weight and therefore people perform well in order to reduce them	Greater attention to losses
The equity premium puzzle (Grossman & Shiller, 1981)	Higher historical real returns of stocks over government bonds, which implies unreasonably high risk aversion	Investors tend to check their portfolio frequently and are loss averse for losses compared to prior worth of assets	Possibility of recession (Campbell & Cochrane, 1999), Minimal requirements
The disposition effect (Shefrin & Statman, 1985)	Investors' tendency to hold losing stocks too much and sell winning stock too early	Aversion to losing in realizing an asset	The reflection effect

Table 2: Outline of the methods of studies reviewed by Fishburn and Kochenberger (1979). The columns denote each study's sample size, median number of items (decisions), type of participants and decisions, and the target point chosen by Fishburn and Kochenberger (1979) as the origin point for modeling data.

Study	N size	Number of items	Participants	Type of decision	Target point
Grayson, 1960	10	11	Oil and gas drilling executives	Organizational	0 for 6 subjects, -150K to -50K for 4
Green, 1963	3	7	Finance and sales personnel	Individual	20% (for all)
Swalm, 1966	13	13	Executives	Organizational	0 (for all)
Halter & Dean, 1971	2	9	Grain farmer, college professor	Organizational	0 (for all)
Barnes & Reinmuth, 1976	2	10	Oil drilling contractors	Organizational	0 (for all)

Figure 1: Individual utility curves taken from Swalm (1966). The utility curves for the two smallest gains and losses appears to be symmetric for man number 1, 27, 10, 13, 19, 18, 37 (7 / 13 cases; marked in blue), with only larger losses showing a negative dip. Copyright 2000 by Harvard Business publishing; all rights reserved.

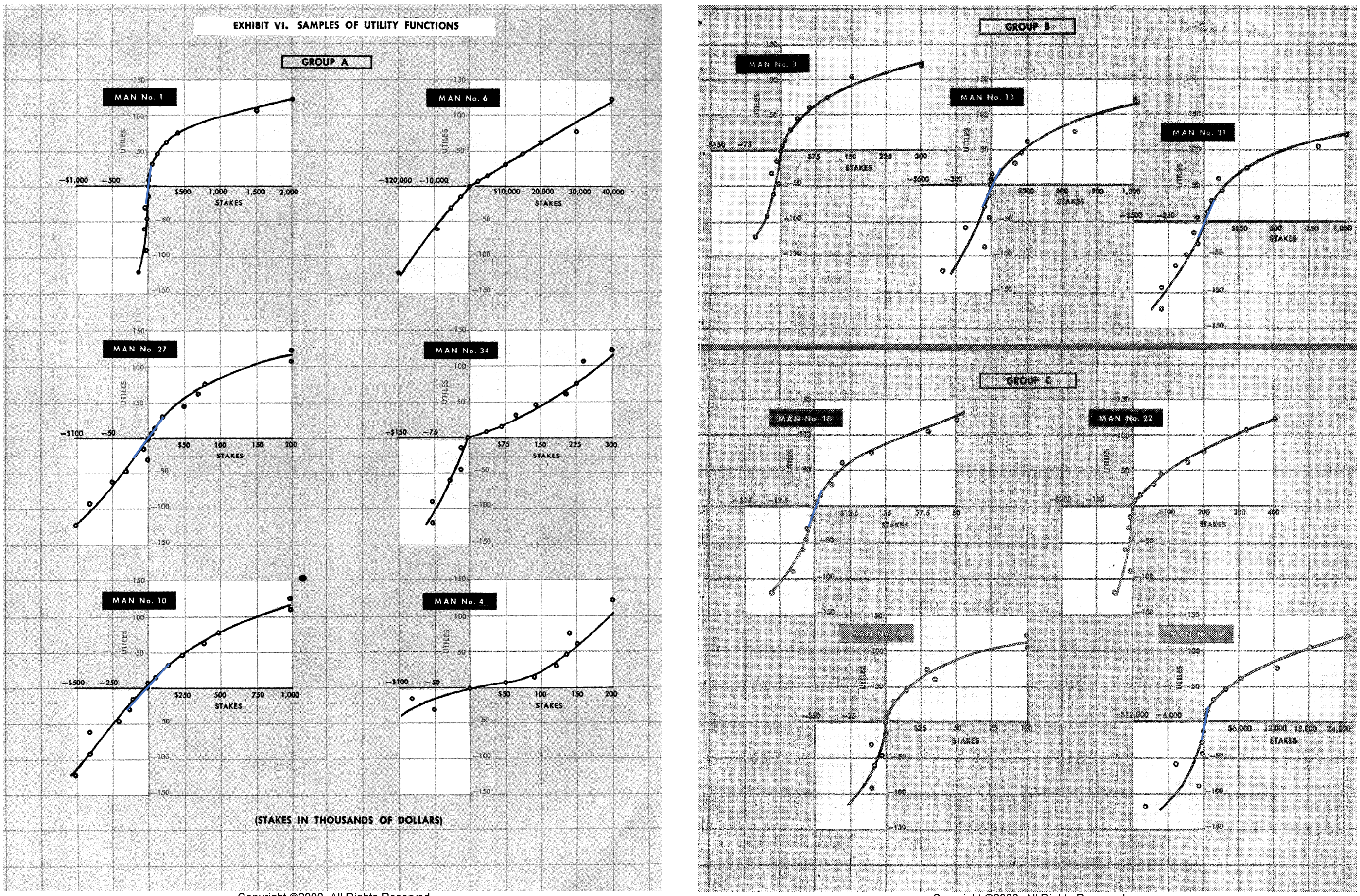


Figure 2: Individual utility curves taken from Grayson (1966). The utility for gains and losses below $100,000 appears to be symmetric for Bill Beard and shows a reversed asymmetry (gain sensitivity) for S.F Bishop (see blue markings). Additionally, for losses below $50,000 the utility is symmetric for John Beard and Fred Hartman (green markings).

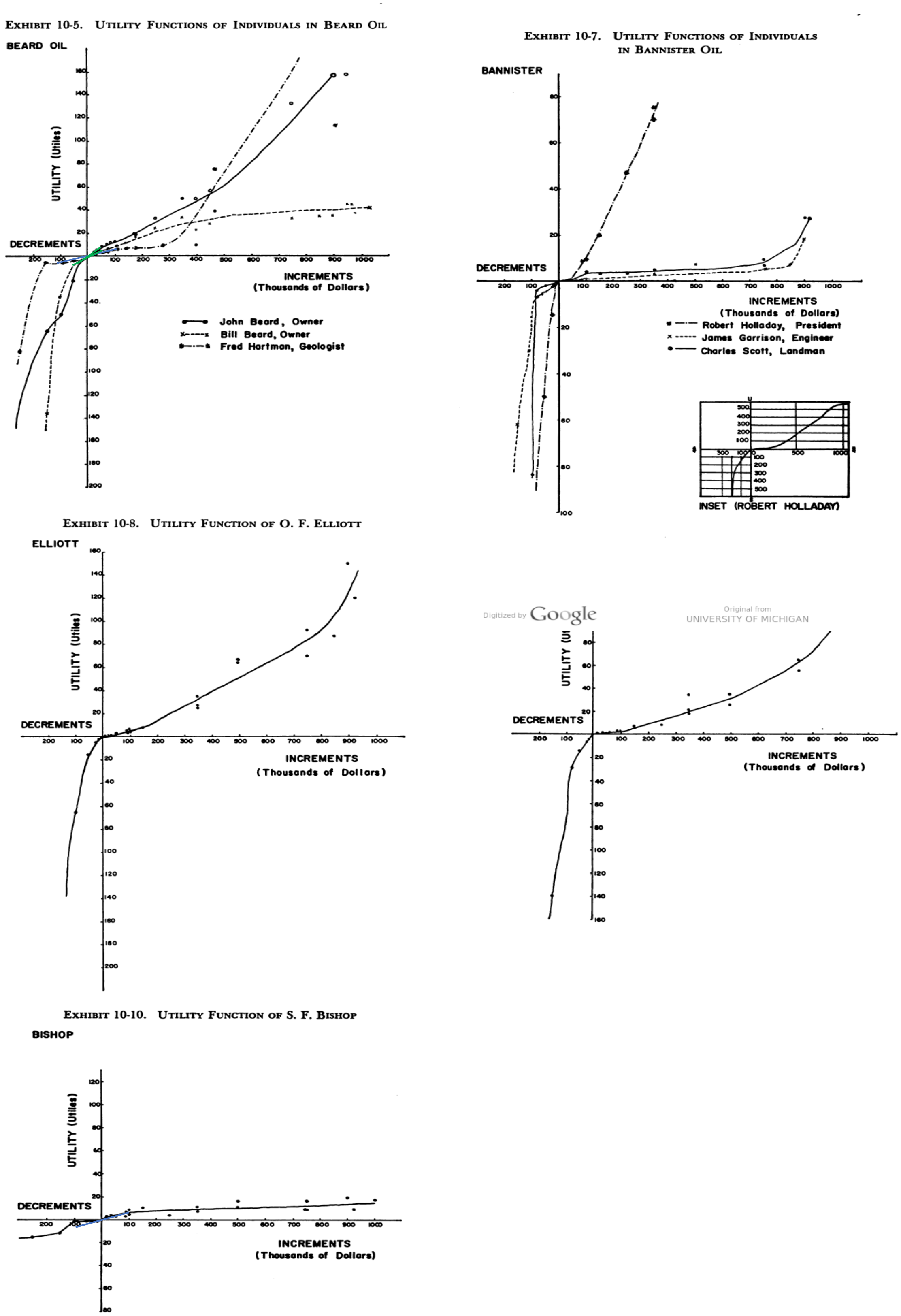
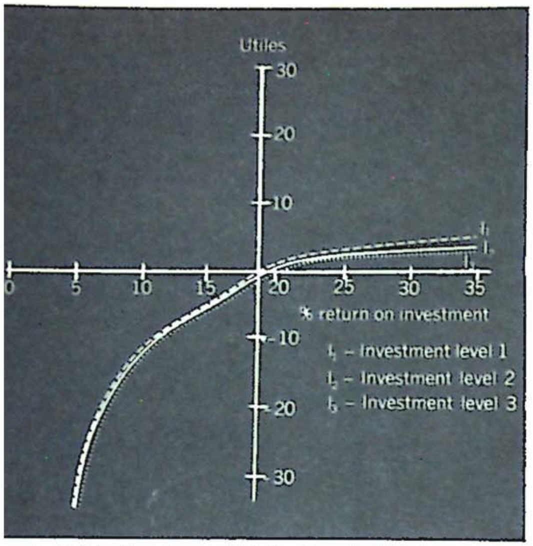


Figure 3: Individual utility curves taken from Green (1963). Notice that all outcomes are gains, and the Y axis crosses at around 20% (the x axis is percent returns on an investment).



re 1. Utility function of H. H., Manufacturing.

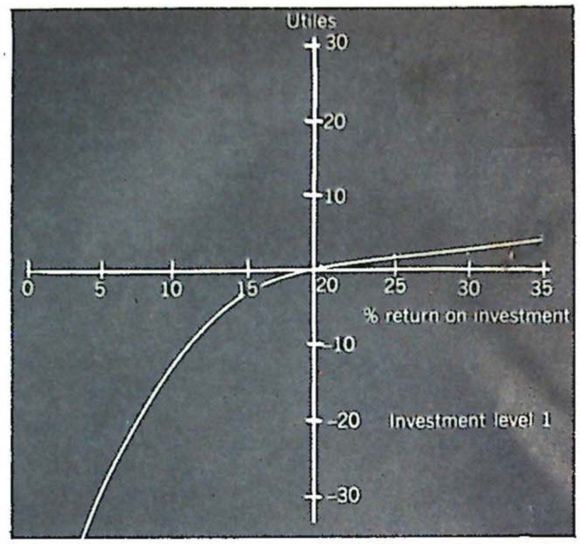


Figure 2. Utility function of individual, R. M., Research.

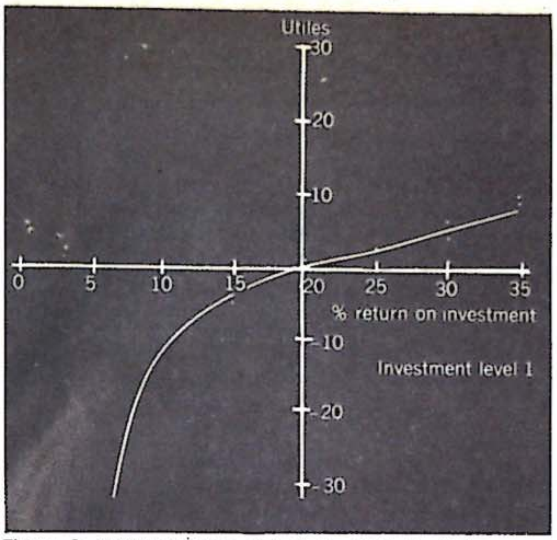


Figure 3. Utility function of individual, W. S., Sales.

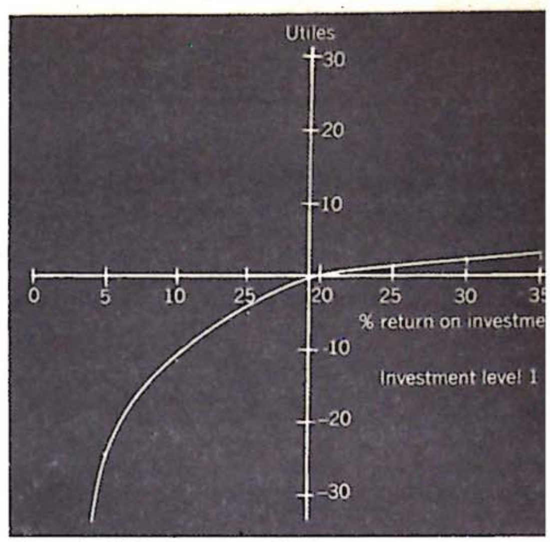


Figure 4. Utility function of individual, J. B., Finance.

Figure 4: Mean utility curves in Davidson et al. (1955) for small amounts (cents). The trendline denotes a polynomial regression curve with an intercept set as zero. Error terms denote standard error.