

# **Rank Dependence in Pay Satisfaction**

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## Abstract

What makes workers happy with their pay? In this paper we show that pure 'rank' matters. It is currently believed that satisfaction is determined partly by an individual's absolute wage (say, 30,000 dollars a year) and partly by the individual's relative wage (say, 30,000 dollars compared to an average in the company or neighborhood of 25,000 dollars). Our evidence suggests that this is inadequate. We show that models developed independently within psychology suggest that satisfaction is gained also by the ranked position of a wage within a comparison set (say, whether the individual is number 4 or 14 in the wage hierarchy of the company). We report two experimental studies, and an analysis of a survey of over 16,000 employees' wage satisfaction ratings. We provide evidence of rank-dependence in pay satisfaction.

## Rank Dependence in Pay Satisfaction

This paper examines the relationship between levels of pay and pay satisfaction. We argue that pay satisfaction is influenced not only by the absolute level of pay, nor simply by relative pay. Instead, the skewness of wage distributions is important. An individual's pay satisfaction is determined partly by the rank ordered position of their wage within a comparison set (e.g. whether they are the third most highly paid person in their organization, the twelfth most highly paid person, etc.).

Understanding the determinants of wage satisfaction is important for a number of reasons. For example, pay satisfaction is a predictor of quit probability (e.g. Clark, 2001), and overall job satisfaction is closely linked with pay satisfaction (e.g. Ellickson, 2002). Furthermore, understanding the effects of wage distribution on the overall level of satisfaction within a workplace is important. A concrete example may serve to motivate the intuitions that underpin the rank-dependent model we develop.

Consider Professor X, a relatively successful member of a small university department. Professor X earns \$20,000 more than the average wage of professors in the department, and only \$10,000 less than the most highly paid faculty member in the department. In fact, Professor X is the third most highly paid member of the department. Compare the likely satisfaction of Professor X with that of Professor Y, a colleague in a different department and better paid discipline. Professor Y earns \$10,000 more than Professor X, corresponding to \$20,000 more than the average wage in Professor Y's department. Thus the salaries of Professor X and Professor Y are the same distance from the mean of their respective departments. Like her less well paid colleague, Professor Y happens to earn just \$10,000 less than the highest wage in her department. However, Professor Y is only the fifth most highly paid person in her department. Who will be more satisfied with their wage — Professor X or Professor Y? Intuition and informal observation suggest that Professor Y *may* be less satisfied than Professor X, despite the fact that she is more highly paid and is identically located with respect with the mean and maximum departmental wages. To the extent this intuition is correct, it suggests that individuals care not just about their wage relative to some reference level, but also about the rank order of their wages

within their comparison set. This idea lies at the heart of the model that we develop and test.

The plan of the paper is as follows. First, we consider existing models of wage satisfaction. We focus on recent models that emphasize the importance of relative wage in contributing to satisfaction. We argue that existing models generally fail to accommodate the fact that multiple reference points may be relevant to judged wage satisfaction (as is required by the intuition of rank-dependent satisfaction). We then set out an alternative account of wage satisfaction, based on a model originally developed in the literature on psychophysical judgment (Range Frequency Theory: Parducci, 1965; 1995). The model assumes rank-dependence — it suggests that wage satisfaction will be predicted partly by the ordinal position of a wage within a comparison set. In this paper this hypothesis is first tested in a laboratory-based experiment, in which the predictions of the rank-dependent model are confirmed. This experimental study is followed by complementary survey-based analyses of wage satisfaction ratings of 16,000 workers from approximately 900 workplaces. The results of this study also provide evidence, using a different methodology, for the importance of rank-dependence. Real-world satisfaction ratings are independently predicted by position in a wage ranking. A final experimental study tests a further prediction of the psychophysical approach to the relation between wage and wage satisfaction. It finds effects of sequential context — the satisfaction given by a reward is influenced by the size of immediately preceding rewards.

### Models of Wage Satisfaction

The Neoclassical View and Reference Dependence. Neoclassical approaches to utility suggest that it will vary positively with the absolute wage level and negatively with the number of hours worked. Workers like income and dislike effort. This can be expressed as follows:

$$u = u(W-abs, h, i, j) \tag{1}$$

where  $u$  is the utility gained from working,  $W-abs$  is the absolute level of income,  $h$  is hours of work, and there are additional parameters associated with characteristics of the individual worker ( $i$ ) and the job ( $j$ ). Much relevant work within psychology has made use of the Pay Satisfaction Questionnaire (Heneman & Schwab, 1979, 1985)

and exploratory and confirmatory factor analysis has led researchers to conclude that pay satisfaction is multidimensional, with typically around four separate factors contributing significantly, one of which is pay level (see e.g. Judge & Welbourne, 1994). This line of research has also typically focussed on absolute, rather than relative, pay levels.

However, recent years have seen the formulation of models intended to capture the intuition that relative wages will be an important determinant of utility. Hamermesh (1975) suggested that utility might be derived from obtaining wages greater than the average wage of an appropriate comparison group. Rees (1993) reviews a number of informal arguments for the importance of relative wages in determining perceived fairness and wage satisfaction. Some data are consistent with this approach. For example, Clark and Oswald (1996), using data collected from 5,000 UK workers, found evidence that utility depends partly on income relative to some reference or comparison income level. Groot and Van den Brink (1999) examined the pay satisfaction of heads of households within the Netherlands and also analysed data from the British Household Panel Survey. In both cases, they found that pay satisfaction was determined by relative rather than absolute level of wages. A number of other studies have emphasized the importance of reference groups and comparisons in determining pay and job satisfactions (e.g. Burchell & Yagil, 1997; Capelli & Chauvin, 1991; Capelli & Sherer, 1988; Finn & Lee, 1972; Goodman, 1974; Hills, 1980; Law & Wong, 1998; Lawler, 1971; Oldham, Kulik, Stepina, & Ambrose, 1986; Patchen, 1961; Ronen, 1986; Taylor & Vest, 1992; Scholl, Cooper, & McKenna, 1987; Trembley & Roussel, 2001; Trembley, Sire, & Balkin, 2000; Ward & Sloane, 2000; Watson, Storey, Wynarczyk, Keasey, & Short, 1996). This is typically expressed as follows:

$$u = u(W-abs, W-mean, h, i, j) \quad (2)$$

where the additional term, *W-mean*, is a reference wage that will be negatively associated with utility. Comparison effects of the type embodied in Equation 2 and the studies listed above have long been a concern of the social sciences outside economics, most notably in studies of relative deprivation (Runciman, 1966). At the interface between economics and psychology, the idea that losses and gains are assessed not in absolute terms but in terms of the change they represent from a

reference point (such as the current state) has received wide currency in prospect theory (Kahneman & Tversky, 1979) and related accounts. However, the implications of concern for relative wealth for economic models has only recently received wide attention (for recent examples see e.g. Blanchflower & Oswald, 2002; Clark, 2000; Corneo, 2002; Corneo & Jeanne, 1997, 2001; de la Croix, 1998; Easterlin, 1995; Frey & Stutzer, 2002; Knell, 1999; Ok & Kockesen, 2000; for earlier research see e.g. Baxter, 1988; Boskin & Sheshinski, 1978; Duesenberry, 1949; Frank, 1985; Hochman & Rogers, 1969; Konrad & Lommerud, 1993; Kosicki, 1987; Layard, 1980; Lommerud, 1989; Oswald, 1983; Stark & Taylor, 1991; Van de Stadt, Kapteyn, & Van de Geer, 1985; Wood, 1978).

Rank Dependence. The models described above generally assume that utility is derived from the comparison between an individual's wage and a single reference or comparison wage. However, the intuition of rank dependence, introduced by the example of Professors X and Y above, suggests that more than one reference point may be used to determining wage satisfaction (cf. Folger, 1984; Kahneman, 1992). Although this issue has received little attention, some existing results are consistent with a multiple-reference perspective. Ordonez, Connolly and Coughlan (2000) presented evidence that the judged satisfaction and fairness of a salary level was determined by separate comparisons of that salary to more than one referent (cf. also Taylor & Vest, 1992). Mellers (1982) examined how individuals chose to achieve "fairness" when they were given a sum of money to allocate between hypothetical members of a university faculty in the light of information about the different levels of merit and contribution of the faculty members. The results ruled out the notion that perceived fairness results when wages are allocated in proportion to merit, showing instead that the whole distribution of merit ratings was seen as important in ensuring fairness. More specifically, perceived fairness results when the relative position of an individual's salary equates to their relative position on the merit scale. The concept of "relative position" is discussed more formally later when we outline the Range-Frequency model. Mellers (1986) extended the model to show that it also accounted for judgments of "fair" allocations of costs (taxes). Ratings of happiness both socially and intrapersonally are determined by the shape (skewness) of the distribution of events being rated (Smith, Diener, & Wedell, 1989), and social comparison effects of income on self-rated happiness are seen in an influence of the skewness of income distributions both within and between nations (Hagerty, 2000).

The considerations reviewed above militate against the idea, assumed in most previous accounts, that multiple reference points may be combined into a single reference point prior to judgment. We present further evidence below.

If it is accepted that multiple reference points may be involved in determining wage satisfaction, the question of how the multiple comparators conspire to produce a single judgment must be addressed. Within the traditional economic literature, relatively little attention is paid to the *distribution* of gains, losses, probabilities, or risks on the treatment of any individual loss, gain, or probability. We now introduce a potential approach to this problem, based on Range Frequency Theory (RFT: Parducci, 1995). Later we note points of potential contact between RFT and some recent developments in rank-dependent utility theory (Quiggin, 1993) and related developments in cumulative prospect theory (Tversky & Kahneman, 1992).

#### Economic Psychophysics: Towards a Model of Rank Dependent Wage Satisfaction

How are judgments (in this case, judgments of wage satisfaction) made as a function of the context of judgment? A substantial body of research has examined context effects on judgment, choice, and decision making within economic and consumer psychology contexts. But the focus of such research has been on using phenomena such as context-dependent preference reversals to undermine rationality assumptions and expected utility theory (see e.g. Kahneman & Tversky, 2000) rather than on developing models of how a set of contextual reference points affects judgment. Contextual effects on judgment have long been investigated within psychophysics (e.g. Parducci, 1965, 1968; 1974; 1995; Parducci & Perrett, 1971), and psychophysical models of contextual effects on judgment have begun to see application in economic and consumer psychology domains (e.g. Birnbaum, 1992; Hagerty, 2000; Mellers, Ordonez, & Birnbaum, 1992; Niedrich, Sharma, & Wedell, 2001; Smith, Diener, & Wedell, 1989; Stewart, Chater, Stott, & Reimers, in press). Our work falls squarely within this tradition of ‘economic psychophysics’, defined as the attempt to bring models of basic psychological processes derived from psychophysics to bear on economic questions.

The idea that judgments (e.g. of a wage) are made relative to a single reference point can be seen as rooted in Helson’s (1964) Adaptation Level Theory. Adaptation Level Theory, developed within psychophysics, assumed that judgments about simple perceptual magnitudes may be made in relation to the weighted mean of contextual stimuli – for example, a weight would be judged as heavy, or a light

judged as intense, to the extent that the weight or intensity exceeded the weighted mean, or adaptation level, for the relevant set of contextual stimuli. The concept of adaptation level, though largely discredited within much of the psychophysical judgment literature from within which it originated, remains influential. For example, within the consumer psychology and economic psychology literatures, accounts framed in terms of “reference prices” or “reference wages” are related to adaptation level theory, for such accounts typically assume that the attractiveness of the wage for a given individual, or a price for a product in a given category, will be determined partly by its relation to the mean wage or price for the given category. Such accounts are currently in widespread use. While “reference point” and “adaptation-level” models assumed that judgments are made in relation to a mean of some kind, there is ample evidence in some domains that judgments are instead made with regard to the endpoints of a contextual distribution and/or the variance of the distribution (see Volkman, 1951; Janiszewski & Lichtenstein, 1999; Stewart et al., in press).

The trend from seeing magnitude perception and judgment as context-independent (analogously to the neoclassical assumptions embodied in Equation 1), through the suggestion that the mean of a contextual distribution is relevant (reference-wage accounts; Equation 2), to the idea that the variance of a distribution is also relevant, finds a natural extension in the observation that the *skewness* of a distribution can also be important. As in the cases above, the relevant models were developed first in the psychophysical judgment literature.

A central idea of RFT (Parducci, 1965; Parducci & Perrett, 1971), crucial to the current proposal, is that the ordinal position of an item within a ranked ordered list of contextual or reference items (a comparison set) will be important in determining judgment over and above the position of the item with respect to the mean and variance of the distribution. Of course, for a given comparison set of items the rank ordered position of an item within the set will be correlated with its absolute value, with its relation to the mean of the comparison set items, and with the item’s location with respect to the lowest and highest values within the set. Thus experimental results that have been interpreted as consistent with reference-wage accounts are not necessarily evidence against rank-dependent accounts. Despite the naturally high correlation between (e.g.) distance from mean and ranked position, such factors are distinct and can be distinguished experimentally. This is illustrated by the distributions in Figure 1 below. The items can be thought of as representing

magnitudes along any psychological continuum (e.g. prices, wages, weights, line lengths).

How will the item marked X be perceived and how will its magnitude be judged? X has the same actual value in distribution A and distribution B. Furthermore, in each distribution X is the same distance from the mean, the same distance from the mid-point, and the same distance from the end points. Nevertheless intuition, confirmed by empirical observation in a number of domains (e.g. Birnbaum, 1992; Mellers, Ordonez, & Birnbaum, 1992; Stewart et al., in press; Hagerty, 2000; Niedrich, Sharma, & Wedell, 2001; Smith, Diener, & Wedell, 1989), suggests that the judged magnitude of X will be lower in distribution A (where X is the second lowest stimulus) compared with the judged magnitude of X in distribution B (where X is the fifth lowest stimulus). Analogous considerations apply, in reverse, for stimulus Y.

Effects of this type suggest that the ordinal value of an item within a contextual set will be relevant to its judged subjective magnitude. This assumption is incorporated into RFT.

Range Frequency Theory. RFT was initially designed to account for the subjective magnitudes that participants report for unidimensional stimuli such as weights, line lengths, or tones varying in frequency. The model (see Parducci, 1995, for a review) incorporates the empirical observations that the rating assigned to a given stimulus is determined both by its position within the range and its ordinal position in the ordered distribution of the stimuli.

This can be expressed as follows. Assume an ordered set of  $n$  contextual items:

$$\{x_1, x_2, \dots, x_i, \dots, x_n\}$$

Then, if  $M_i$  is the subjective psychological magnitude of  $x_i$ :

$$M_i = wR_i + (1-w)F_i \tag{3}$$

where  $R_i$  is the range value of stimulus  $i$  ( $S_i$ ):

$$R_i = \frac{S_i - x_1}{x_n - x_1} \tag{4}$$

and  $F_i$  is the frequency value, or ranked ordinal position of  $S_i$ , in the ordered set:

$$F_i = \frac{i-1}{n-1} \quad (5)$$

Thus the subjective magnitude of a stimulus is assumed by RFT to be given by a convex combination of R and F. It is a weighted mean of (a) the position of the stimulus along a line made up of the lowest and highest points in the set, and (b) the rank ordered position of the stimulus with regard to the other contextual stimuli. ( $M_i$  is constrained to values between 0 and 1 in the formulation given above; if subjective magnitude estimates are given on, e.g., a 1 to 7 scale, then appropriate linear transformation is incorporated.) Here  $w$  is a weighting parameter which is often empirically estimated at about .5.

It is important to note that (a) RFT can be interpreted most conservatively as a descriptive rather than a process account, and that (b) it has generally, although not exclusively, been applied to judgments such as magnitude or attractiveness ratings rather than to actual choice behavior.

Application of Range Frequency Theory to Wage Satisfaction. The RFT principles described above provide a simple formal framework within which intuitions about the rank-dependence of wage satisfaction can be expressed and tested. More specifically, we hypothesize that wage satisfaction ratings will be governed by the position of the rated wage within an ordered set of comparison wages and with respect to the highest and lowest range in the comparison set. In other words:

$$u = u(W-abs, W-mean, W-rank, W-range, h, i, j) \quad (6)$$

where W-rank and W-range are, respectively, defined for wages as in Equations 4 and 5. Hence Equation 6 nests the two approaches.

Note that W-abs and W-mean remain in the model. If RFT were to govern wage satisfaction ratings completely, W-abs and W-mean would have no influence on  $u$ . However, we leave them in the equation in order to test the complete model using the regression-based logic described below.

Before turning to new empirical evidence, we note that the account we offer attempts to link a psychophysical model to an economist's notion of utility. What reason is there to believe that a unified account might be possible?

Many paradigms that have been used to study economic choice and judgment essentially involve the assignment of numbers to represent psychological magnitudes, or a choice of actions based on the internal psychological magnitude associated with some state of affairs. Self-ratings of happiness or wage satisfaction exemplify straightforward cases where participants must provide numbers on a rating scale to indicate some aspect of their internal state. However, the judgment of the attractiveness of a particular market price, and/or the consequent decision whether to purchase product A or product B, will also be influenced by the position of the market price on an internal psychological "attractiveness" or "value" scale. Similarly, the choice of certainty equivalent (CE) for a particular gamble may depend upon the internal psychological magnitude of the riskiness of the gamble under consideration, and indeed the certainty equivalent (CE) assigned to a given gamble varies as a function of the range of CEs provided at decision time (Stewart et al., in press) and the distribution (positively vs. negatively skewed) of options available at the time of choice is influential (e.g. Birnbaum, 1992). It therefore seems reasonable to test the possibility that judgments of utility and satisfaction may conform to the same principles as psychological magnitude judgments more generally.

There is already reason to believe that the principles embodied in RFT may be relevant in mediating the relation between income and happiness generally. Smith, Diener, and Wedell (1989), in a laboratory-based study, found that RFT gave a good account of both overall happiness ratings, and individual event ratings, when the happiness-giving events were drawn from positively and negatively skewed distributions. Hagerty (2000) concluded that, as predicted by RFT, mean happiness ratings were greater in communities where the income distributions were less positively skewed. Hagerty found that this effect held both within and across countries. In addition, as we noted above, Mellers (1982, 1986) found that RFT gave a good account of the judged fairness of wage distributions.

Job and pay satisfaction ratings are more than mere noise. Wage satisfaction or job satisfaction measures (often closely related) are reliable over time (see Bradburn & Caplovitz, 1965) and correlate with measures of both mental and physical health (e.g. Palmore, 1969; Sales & House, 1971; Wall, Clegg, & Jackson, 1978).

Satisfaction measures are systematic in that they can be predicted reliably (see e.g. Experiment below). Furthermore, such measures predict behavior such as quit probability (see e.g. Clark, 2001; Shields & Ward, 2001).

In this paper, we present three studies to test the Range Frequency Theory on wage satisfaction data acquired both in laboratory and real-life surveys. The first, laboratory-based experiment, upheld the predictions of RFT in an artificial environment. The second study generalised the conclusions of the first experiment using a large sample of comprehensive survey data to back up the powerful prediction of RFT model. A final experimental study tests a further prediction of the economic psychophysics approach to the relation between wage and wage satisfaction. It finds that strong sequential context effects are observed when wages are not simultaneously presented.

### **Investigation 1**

The aim of our first experiment was to use relatively “clean” wage satisfaction data, derived from a laboratory setting, to examine the explanatory ability of the rank-dependent model. The data from such an experiment, although obtained under controlled conditions, are inevitably somewhat artificial, and so we adopt complementary methodologies. In the next section, Investigation 2 tests the rank-dependent model using large-scale survey-based data, where the results may be less noise-free but should be more realistic.

In Investigation 1, we asked undergraduates -- a relatively homogeneous group -- to rate how satisfied they would be with a hypothetical wage they might be offered for their first job. The key experimental manipulation was of the distribution of other hypothetical wages said to be offered to their classmates for similar jobs. In other words, the task was to rate satisfaction of a potential wage in the context of a set of other potential wages.

Six different wage distributions were used, with the aim of testing the key predictions of RFT as applied to wage satisfaction. There were 11 hypothetical wages in each distribution, and each participant was required to rate how satisfied they would be with each of the 11 wages in the context of the distribution as a whole. The six wage distributions are illustrated in Figure 2, while the actual wages used in each distribution are listed in Table 1. The first two distributions (A and B; denoted unimodal and bimodal respectively) are designed to test the key prediction of rank-

dependence, and follow the logic illustrated in Figure 1. Three wages are common to both distributions (excluding the lowest and highest wages); these are labelled. A1 – A3 and B1 – B3. A1 and B1 are the same distance from their respective distribution means, and are also the same proportion up the range from lowest to highest in their respective distributions. Thus according to a simple reference-wage view, A1 and B1 would be given the same ratings, as would A2 and B2, and A3 and B3. According to rank-dependence, in contrast, A1 will be rated as less satisfying than will B1 (because A1 is the second lowest wage, while B2 is the 5th lowest). The reverse will be true for A3 and B3, while A2 and B2 should receive the same rating in both cases. Thus distributions A and B allow a clean test of the effect of rank dependence with range and mean held constant.

The next two distributions, C (positive skew) and D (negative skew), are included for completeness, to test the ability of the model to account for the whole range of satisfaction ratings when the distribution is negatively (or, more realistically, positively) skewed. The distributions have two points in common. The fifth-highest wage in the negatively skewed distribution is the same as the second-highest wage in the positively skewed distribution, and the second-lowest wage in the negatively skewed distribution is the same as the fifth-lowest wage in the positively skewed distribution. However, any difference in satisfaction ratings is theoretically ambiguous because the relevant wages differ between the distributions in both ranked position and in distance from the mean. The final two distributions, E (low range) and F (high range), allow a pure test of the idea that position up the range is important in determining wage satisfaction. The critical sixth-lowest wage is the same in both distributions, and represents both the mean and the median in each distribution. However, in the low range condition the critical wage is 60% up the range from lowest to highest wage, while it is 40% up the range in the high range condition. Thus any difference in the satisfaction rating given to this critical wage will be unambiguous evidence for an effect of the position-within-range of a wage.

In summary, the collection of wage satisfaction ratings for the six distributions allows the predictions of rank-dependent, reference-dependent, and range-dependent accounts of wage satisfaction to be pitted against one another in a laboratory setting.

## Method

Participants. Twenty-four first-year psychology students (17 women and 7 men, mean age=19.0 years) participated for course credit.

Materials. Six rating scales and 66 coloured labels were used in the experiment. Rating scales were 36 cm long and 4 cm wide strips of paper, on which a 7-point scale (34 cm long) was drawn in the centre of the strip. Each scale had seven equally spaced markers indicated (labelled 1-7). No other written information was present on the scale. Small labels were constructed to represent the wages to be rated. Annual wages were printed in a rectangular box on the labels, and the top of each label was made in the shape of a pointer that could be used to indicate the satisfaction rating of the hypothetical wage indicated on the label by placing the label's pointer at the appropriate place on the scale.

Design and Procedure. The experimental design was within-subjects, with six levels of annual wage distribution (as illustrated in Figure 2 and described above). Table 1 lists the actual wage values used in the experiment. A 6 x 6 Latin square design was used to counterbalance the presentation order of the distributions.

Participants were tested individually and given standard written instructions. They were then given 11 labels, on each of which an annual salary was written. They were asked to imagine that these were starting salaries offered to similar graduates entering a similar occupation. They were then required to place the labels on a 7-point rating scale, with 1 corresponding to "least satisfied," and 7 to "most satisfied". After they finished their rating, the experimenter noted the positions the labels were placed in, and a new rating scale was provided to participants with a different set of labels corresponding to another distribution.

## Results

Model-based Analysis. The results are shown in Figure 3, together with the fits of the model we describe below. We analyse the results in two ways. First, we examined the ability of the RFT model to fit the data, and then we carried out conventional statistical analysis to compare the common points between different distributions.

We took the RFT model (Equation 3) and obtained maximum likelihood parameter estimates using squared error minimisation. This is akin to fitting standard OLS of satisfaction responses on rank and range as covariates, but where the parameters are constrained to be  $w$  and  $1-w$ .

There is just one free parameter: the parameter  $w$  that specifies the weighting given to the ranking dimension relative to the range dimension. We adopt the conservative procedure of holding  $w$  constant for all six distributions; there was therefore just a single value of one parameter to estimate for all 66 data points (11 in each of 6 distributions). The fit, from the pooled estimates, is shown as a solid line in each of the three figures (Figure 3a to 3c). The overall  $R^2$  value obtained was .998, and the estimate of  $w$  was .64.

Model comparison statistics confirmed the importance of both the range and the rank dimensions. We compared the goodness of fit of the model with and without the  $w$  parameter included (Borowiak, 1989). The resulting  $\chi^2$  values were adjusted using the Aikake procedure (Aikake, 1983) to take account of the additional parameter available in the version of the full model. A restricted model in which only range influences ratings produced a significantly less good fit: ( $\chi^2(1)=241.9, p<.001$ ) as did a restricted model in which only ranked position influenced satisfaction ratings: ( $\chi^2(1)=169.1, p<.001$ ).

The above analysis has implicitly assumed that the psychological magnitudes of wages, prior to rating, are a linear function of actual wage amount. We considered the possibility that a logarithmic or power-law transformation of the wage variables would improve the fit of the model. In neither case was there a significant increase in the explained variance.

Conventional Statistical Analysis. The differences in the mean rating of common points in comparative conditions were analysed using ANOVA.

There were three critical wage stimuli for the unimodal and bimodal distributions, corresponding to the points labelled A1 through B3 in Figure 2. These points permit a test of the effect of rank when proportion up the range, and distance from the mean, are both held constant. An initial two-way ANOVA on the ratings given to the common points found, as expected, a main effect of point within distribution ( $F(2,46)=809.17; p<.0001$ ); no main effect of distribution ( $F(1,23)=0.60; p>.445$ ), and an interaction between them ( $F(2,46)=124.68; p<.0001$ ). Post-hoc tests confirmed that the wage of £20.0K was rated as less satisfying when it was the second lowest wage than when it was the fifth lowest wage ( $t(23)=-8.034, p<.0001$ ) and that the wage of £25.6K was rated as more satisfying when it was the second highest wage than when it was the fifth highest ( $t(23)=7.746, p<.0001$ ).

In the comparison of positive-skew and negative skew conditions, £19.5K and £26.1K were the common salaries appearing in both conditions. The range difference between these points and the endpoints were the same in both conditions, but the positions in the rank orders were different. The salary £19.5K is the fifth lowest wage in the positive-skew condition but the second lowest in the negatively skewed condition. Conversely, £26.1K ranks second highest in the positive-skew condition but fifth highest in the negative-skew condition. As the mean of the two distributions were not the same, the distance of the common points to the mean were also different. A 2 x 2 (common points X condition) ANOVA was used, and found the expected main effects of condition (ratings were higher in the positively skewed condition:  $F(1,23)=159.99$ ;  $p<.0001$ ) and point (ratings were higher for wages in the positive condition:  $F(1,23)=1860.02$ ;  $p<.0001$ ). The interaction was not significant ( $F(1,23)=1.0$ ). A post-hoc test was conducted, and the results show that ratings were consistently higher in the positively skewed than in the negatively skewed condition for both the lower wage ( $t(23)=11.82$ ,  $p<.0001$ ), and the higher wage: ( $t(23)=11.09$ ,  $p<.0001$ ).

The single common point for the high-range and low-range conditions was examined in a similar fashion. Salary £22.8, which was the mean and the median of the distribution, has the same ranked position in both distributions, but different range values. A paired-sample t-test was used, and the analysis revealed, consistent with the predictions of RFT, that the effect of range was significant:  $t(23) = 2.435$ ,  $p<.05$  (two tailed).

### Discussion

The laboratory-based satisfaction data collected in this experiment were explained well by RFT. A high proportion of the variance was captured by the model. The fit of the RFT model, supported by conventional statistical analysis, provided evidence against the predictions of reference-dependence in satisfaction, and for rank-dependence.

## **Investigation 2**

The generality of these laboratory-based findings is limited. The satisfaction ratings were garnered with respect to hypothetical, rather than actual, wages. No information about the prospective jobs, other than wage levels, was provided. An explicit comparison set, provided by the experimenter, was given to participants and

the methodology of the experiment implicitly encouraged the production of relative, rather than absolute, satisfaction ratings. It is therefore unclear whether the results generalise to real-world settings. In keeping with our aim of adopting complementary methodologies, we designed a further study in an attempt to gain evidence for rank-dependence in wage satisfaction. More specifically, Investigation 2 tested the prediction of rank-dependence on a sample of approximately 16,000 workers in approximately 900 workplaces within the UK. To anticipate: this different methodology led to conclusions consistent with those of the laboratory-based experiment.

### Method

We report a number of analyses under the heading of Investigation 2, but all used the same regression-based logic to estimate self-reported satisfaction on a number of dimensions. The aim was to determine whether the ranked position of an employee's wage within the employing organisation would independently predict satisfaction measures when as many other measures as possible were partialled out. Although the focus is on wage satisfaction, other satisfaction measures are also available from the samples we used and we report those here as well.

Data were taken from the Workplace Employee Relations Surveys (WERS). This UK-based survey has been conducted four times, originally in 1980 as the Workplace Industrial Relations Survey. Each survey is based on a representative sample of over 2,000 workplaces/establishments. The most recent survey was in 1997-1998 (WERS98); this was the first to include employee questionnaires and it is these that provide the data for the research reported here. All places of employment in Britain (including schools, shops, offices and factories) with ten or more employees were eligible to be sampled. WERS98 achieved participation from 2,191 workplaces, but 19 per cent of these refused to allow employee response to the worker questionnaire or agreed but ultimately did not provide responses. This left 1782 workplaces offering such survey responses. Some of these cases are eventually dropped in later regression analysis because of missing information on particular questions. Approximately 28,000 employees contributed completed questionnaires (a response rate of 64%); up to 25 employee questionnaires were distributed to randomly-selected employees within each organisation. The design of WERS98 is summarised in Cully (1998); initial findings from the study are described in Cully et

al. (1998). The WERS98 data are available to researchers through the Data Archive of the Economic and Social Research Council (UK).

Employees were given self-completion questionnaires. They could return them either via the workplace or directly to the survey agency. Questions focussed on a range of issues including Employee Attitudes to Work, Payment Systems, Health & Safety, Worker Representation, and other related areas. The data of particular relevance to the current project concerned wage measures and job satisfaction measures. The dependent variables we used were four measures of satisfaction, as listed below. The WERS98 “Employee Questionnaire” included a question (A10) phrased as follows: “*How satisfied are you with the following aspects of your job?*” Four aspects were listed: “*The amount of influence you have over your job*”; “*The amount of pay you receive*”; “*The sense of achievement you get from your work*”, and “*The respect you get from supervisors/line managers*”. In each case one box representing a position on a five-point scale was ticked; the box labels ranged from 1 (Very Satisfied) to 5 (Very Dissatisfied). A sixth “Don’t Know” option was also available. These satisfaction measures were the predicted variables in the following analyses, but for numerical ease of interpretation the scaling here is reversed (so that 5 is the highest level of satisfaction).

We divide predictor variables into wage-related variables (those of interest to the present hypotheses) and background variables (those that were included in the regression equation to partial out the effects of the relevant factors). Background variables are listed in Table 2. The pay variables we used as predictors were as follows.

1. *W-abs*. Weekly pay of individual  $i$
2. *W-mean*. Average pay of workplace  $j$
3. *W-rank*. Rank of individual  $i$  in workplace  $j$  as proportion of number of workers, where greater rank indicates the worker is higher up the pay scale. This was calculated as  $(\text{rank}_{ij} - 1) / (\text{number of observations workplace}_j - 1)$
4. *W-range*. The proportion up the range of  $\text{pay}_i$  in workplace  $j$ . This was calculated as  $(\text{pay}_i - \text{pay}_i^{\min}) / (\text{pay}_i^{\max} - \text{pay}_i^{\min})$

*W-abs* and *W-mean* were logarithmically transformed prior to analysis in all cases except where noted. These measures were expected to be highly correlated. The crucial measure for our hypothesis is *W-rank*. If the predictions of our model hold true

for the wage satisfaction ratings of employees in the workplace, we would expect the *W-rank* and the *W-range* measure to predict self-reported levels of pay satisfaction even when the effects of other variables are partialled out statistically.

### Results

Initial analyses were carried on data collected from all workplaces with at least 15 employee pay observations. The resulting sample contained 16,266 individuals from 886 separate workplaces.

The correlations between the main variables of interest are shown in Table 3, where some patterns are evident. The different satisfaction measures intercorrelate at a moderate to high level. The wage measures are highly intercorrelated, with *W-abs* (log transformed) having a correlation greater than .6 with all of *W-rank*, *W-range*, and *W-mean* (log transformed). Of particular relevance to the hypothesis of rank-dependence: *W-rank* was more highly correlated with pay satisfaction than was any other pay measure.

Ordered probit analyses were undertaken. The background measures listed in Table 2 were always included, although we do not report the coefficients for these variables. All columns in the regression results tables reported below were estimated by the Ordered Probit technique. Standard errors are in parentheses and are robust to arbitrary heteroscedasticity and the repeat sampling of individuals within establishments. The Pseudo R<sup>2</sup> values were calculated using the McKelvey-Zavoina method. Pay measures were log transformed in all cases, although each analysis was also repeated with untransformed measures, and similar results were obtained.

An initial analysis examined whether the effect of absolute pay level on satisfaction measures was similar in the restricted sample of organisations that we used (the N=888 organisations with data from at least 15 employees) compared with the complete sample (N=1747). Table 4a shows the results for the complete sample; Table 4b shows the results for the restricted sample. In both the full and the restricted sample *W-abs* is a significant independent predictor of each satisfaction measure when the effects of the background variables are partialled out. More importantly, the coefficients were similar in both samples. This preliminary analysis provided reassurance that the restricted sample was representative in relevant respects; subsequent analyses focussed on the restricted samples alone as it was deemed necessary to have a sufficient number of data points for each organisation (at least 15) for analysis of *W-range* and *W-rank* variables to be interpretable.

The result of adding *W-mean* into the equation is shown in Table 5. *W-mean* accounted for no significant additional variance in pay satisfaction, while absolute pay level remained a significant predictor. For the other satisfaction measures, *W-mean* was a small negative predictor of satisfaction. The results of this analysis should be treated with caution, however, due to the high correlation between the variables (.65). Next, the *W-rank* and *W-range* measures were added into the equation, and the results are shown in Table 6a. Again, the results should be interpreted with considerable caution due to the high intercorrelation between the variables (particularly *W-rank* and *W-range*:  $r=.8$ ). All four pay-related predictors predicted independent variance in pay satisfaction ratings, although the coefficient for *W-mean* was, unexpectedly, positive.<sup>1</sup> The other three satisfaction measures were, as before, not predicted by *W-mean*. One possible interpretation of the positive mean-wage finding is that workers view themselves as having better financial prospects in a highly-paid workplace.

Due to the high intercorrelations between the pay related variables, further confirmatory analyses were carried out in which the only predictors were *W-abs* and either *W-rank* (Table 6b) or *W-range* (Table 6b). In these analyses, both *W-rank* and *W-range* accounted for significant additional variance beyond that accounted for by *W-abs* and the background variables.

In summary, wage satisfaction in this sample of over 16,000 employees from almost 900 separate organisations was predicted by (a) the absolute level of pay, (b) the ranked position of pay within the organisation, and (c) the position of pay with respect to the lowest and highest pay levels that were sampled.

We addressed one possible objection in a further set of analyses. The analyses above have implicitly assumed that all salaries in an organisation are relevant to determination of a rank-dependent satisfaction rating. An alternative possibility is that the comparison set that provides the context within which wage satisfaction is assessed is determined partly by occupational similarity. To return to the example of Professors X and Y with which we opened the paper, intuition suggests that Professor X's wage satisfaction will be determined primarily by the ranked position of X's wage with respect to that of other academic professors within the department, and less

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<sup>1</sup> This effect was smaller in the analysis in which pay values were not logarithmically transformed.

by the ranked position of the wage with respect to other (less occupationally similar) employees within the institution such as the Dean, the President, or clerical staff.

More generally, one might hypothesise that two processes are involved in determination of wage satisfaction. The first process involves selection of a comparison or contextual set containing multiple salaries, while the second process involves arrival at an overt satisfaction rating on the basis of the items within the comparison set. The present paper addresses primarily the second process, but it is likely that the first process (selection of a comparison set) involves some kind of similarity-based sampling. For example, one might include in one's comparison set people of similar age and wage to oneself, those of people in similar occupations, and those who are geographically close. There is evidence that human memory works in a way that would lead to formation of such a comparison set (e.g. Brown et al., 2002; Hintzman, 1988; Nosofsky, 1986). The full complexities of such processes fall outside the scope of the present study. However, we were able to address the issue in a small way, by examining a subset of the WERS98 data taking into account occupation (using the Occupational Group code collected as part of WERS98). More specifically, we examined the satisfaction ratings from employees as a function of the range and rank of their wage in relation to other employees from the same occupational category.

We used the regression approach exactly as described above to predict satisfaction ratings from employees in terms of the wages of other employees in the same organisation and the same occupational group. We confined analysis to the largest occupational group within an organisation, and used only cases where there were at least 10 employee observations in the largest occupation. This reduced the sample size to 4744 individuals from 373 separate workplaces.

To summarise: The results were essentially identical to those obtained in the larger analyses on groups not differentiated by occupation, although the effect of *W-range* was weaker or absent. We report only the final analyses – those that examine, separately, the effects of *W-rank* and of *W-range* when the effects of *W-abs*, as well as the effects of all other background measures, are partialled out statistically. The results of these analyses are shown in Tables 7a and 7b. It is evident that wage satisfaction, as well as most other satisfaction measures, is independently predicted by *W-rank* when the effect of *W-abs* is partialled out. This is consistent with the results of the earlier analyses in which occupational group was not considered. However *W-*

*range* did not independently predict pay satisfaction, although it did predict other satisfaction measures.

Other analyses produced similar results to the more inclusive analyses, with some minor exceptions as follows. First, *W-rank*, but not *W-range*, contributed independent variance in the combined analysis in which *W-abs*, *W-mean*, *W-rank*, and *W-range* were all included. (In the equivalent analysis for the larger sample, reported in Table 6a, both *W-rank* and *W-range* were independently significant.) Secondly, in the same combined analysis, the positive coefficient linking *W-mean* to pay satisfaction was not statistically significant in the analysis of untransformed variables.

Overall, then, the result of this further analysis in which only same-occupation wages were assumed to enter into the calculation of range-dependent wage satisfaction led to conclusions consistent with the key hypothesis of rank-dependence: *W-rank* influences wage satisfaction over and above actual wage (*W-abs*).

### Discussion

The survey-based study produced results consistent with the hypothesis that an individual gains utility from the ranked position of his or her wage within a comparison set. The absolute level of pay and the distance of his or her wage from a “reference” wage also both matter. At a more general level, the results can be seen as support for the general approach of economic psychophysics – it appears that theoretical leverage can be gained by importing theories of judgment derived from psychophysics into economic theory. The same cognitive principles may govern the way in which judgments are affected by context in many different domains.

The analysis of Investigation 2 is subject to limitations. The high intercorrelations of predictor variables sometimes render the coefficients of the regressions difficult of interpretation. The data were limited in that wage levels were only available from a sample of employees within each workplace, and *W-range* and *W-rank* were calculated only with respect to the sample rather than the full organisation (although this limiting sampling will go against the hypothesis in that additional noise will make significant findings more difficult to obtain). Many of these difficulties are intrinsic to survey methodology, and this highlights the potential usefulness of adopting converging methodologies, ranging from tightly-controlled laboratory-based studies (e.g. Investigation 1) to large-scale surveys (Investigation 2).

### Investigation 3

The results of the first two investigations converge on the conclusion that context effects and multiple reference points are important in determining wage satisfaction. The specific model that we tested (rank-dependence) was motivated by theoretical work conducted independently in the psychophysics of judgment. In the final experiment, we continue the programme of economic psychophysics and test a further prediction derived from psychophysical modelling. The further prediction is that sequence effects will be seen in reward satisfaction ratings, such that the satisfaction given by a cash reward will be determined not just by the size of the reward but also by the size of immediately preceding (recently obtained) rewards. Investigation 3 tests the prediction of sequential effects, and also allows the generality of the rank-dependency effects to be extended to a case when rewards are presented sequentially.

We used a laboratory-based methodology in which participants received real rewards. The aim was to test the prediction that sequential effects, of the type found in psychophysical judgment, will also be found when judgments of reward satisfaction are made. More specifically, it is well established in the psychophysics literature that there are strong sequential effects on judgment. For example, in the judgments of simple perceptual quantities such as loudness or weights, the judgment  $R_n$  of the magnitude of a given stimuli in a sequence,  $S_n$ , is influenced by the magnitudes of stimuli presented on previous trials (e.g.  $S_{n-1}$ ,  $S_{n-2}$ ) and also by the responses given on previous trials ( $R_{n-1}$ ,  $R_{n-2}$  etc) (e.g. Ward & Lockhead, 1971; Laming, 1997). More specifically, responses on trial N tend to be assimilated towards (positively correlated with) stimuli and responses on immediately preceding trials, but contrast with (are negatively correlated with) stimuli and responses from trials further back in the sequence. Similar tendencies are observed whether judgments of subjective magnitudes are made or items must be identified on the basis of their perceived magnitude.

Recent models of judgment have therefore embodied the suggestion that judgments made in a series are largely or entirely context-dependent, in that they are made by comparison with immediately preceding items (see Stewart, Brown, & Chater, 2002, for a mathematical model). In Experiment 3 we test the hypothesis that similar sequential effects will be seen in judgments of wage satisfaction. If the hypothesis of economic psychophysics – that judgments of economic quantities such

as wage satisfaction are governed by the same principles as are judgments of sensory magnitudes — is correct, sequential effects in judgments of rewards will be seen. For example, will a given reward be less satisfying if the immediately preceding reward is large, compared to the case when the immediately preceding reward is small? Such effects may, however, be expected to be smaller than are seen in the case of decontextualised stimuli such as loudnesses, as absolute information is readily available when rewards are presented to participants, as below, in the form of actual numbers.

We wished to create an environment in which participants received a sequence of differing rewards for performing some task, and rated their satisfaction with each reward immediately after it was received. As it was necessary to have experimental control over the distribution of rewards (in order to include an additional test of the predictions of RFT) it was therefore not possible to make rewards contingent on performance. We therefore chose a task (perceptual identification of simple perceptual stimuli) that was sufficiently difficult that participants could not be confident whether they had responded correctly or incorrectly on any given trial. Participants were rewarded for their performance on each trial of the perceptual identification task, and were required to rate their satisfaction with each reward. Participants were paid a percentage of their obtained rewards on completion of the experiment.

### Method

Participants. Sixty-six students (34 women and 32 men, mean age=20.36 years), all studying at the University of Warwick, participated in this experiment and were paid £2.00 for participation. This sum was presented to participants as being a percentage of the rewards they received throughout the experiment; participants were thus aware that each reward they received during the experiment would be reflected in the payment they would receive at the end of the experiment. The duration of the experiment was approximately 15 minutes. Data from seven participants were discarded prior to analysis as these participants failed to comply with instructions to use response points within the range of the specified scale.

Materials. A computer program generated a sequence of events for each trial, as follows. Participants first heard a tone stimulus (one of nine possible stimuli) from a speaker. They were prompted to respond with the identity of the tone (a number between 1 and 9, with 1 corresponding to the lowest frequency tone and 9

corresponding to the highest frequency tone) by typing their response into the computer. Next, a reward amount was presented on the computer screen (e.g. “Your reward is 95 pence”) and participants were required to type how satisfied they were with the reward. The satisfaction rating was required to be a number (not necessarily integral) between 1 and 7 (with 1 corresponding to “least satisfied” and 7 to “most satisfied”). Every participant received 78 trials of this type.

The nine different tones used in the perceptual identification experiment were taken from Brown et al. (2002) and were selected as they had previously been found to lead to a moderate level of correct identification performance (around 45%). The level of performance in the present procedure was expected to be lower as feedback was not provided. (Indeed, the mean accuracy observed in the tone judgment task proved to be 30.2% in the present experiment). The stimulus values are listed in Table 8, along with observed performance. Participants were individually tested in quiet cubicles.

Design and Procedure. The experimental design was between-subjects, with four reward distributions (unimodal, bimodal; low range, and high range), and two overall levels of reward (high and low). In the high-reward distribution, participants were rewarded with a number of pounds on each trial; in the low distribution the same numbers were used but presented as pennies. Table 9 lists the actual wage values used in the experiment. Each distribution contained 13 different rewards, and each of the 13 rewards was given 6 times to each participant. The tones and rewards were presented in blocks. In each block, there was no repetition of tones or reward. Within each block, the order of the presentation of a tone/reward was randomized. Tones were presented in blocks of 9, and rewards were presented in blocks of 13. When the experiment started, standard instructions appeared on the screen. Participants were informed that they would hear 9 ascending tones numbered 1-9, and would be asked to identify them later. It was explained that they would be rewarded every time they gave a response identifying the number of the tone, but that the rewards might not be systematically related to the accuracy of their responses. Participants were required to rate their satisfaction with each reward. It was made clear that the accumulated reward would be calculated at the end of the experiment and that participants would then receive a proportion of their earnings from the experiment. The actual proportion was 5% for the low reward conditions, and 0.05% for the high reward conditions.

## Results

The primary purpose of the investigation is to investigate the theoretically critical sequence effects, and an additional purpose is to examine whether the predictions of RFT hold good when a sequence of rewards is presented sequentially as in the present investigation. We report the analysis of sequential effects first, and then report the fit of RFT to the data.

Sequence Effects Analyses. Two separate analyses were undertaken, to examine the effects on each reward satisfaction rating of (a) previous rewards and (b) previous satisfaction ratings. (As rewards and satisfaction ratings are highly correlated, it is not feasible to compare the effects of prior rewards and prior satisfaction ratings within a single analysis.) To anticipate: clear effects of sequential context were found; the satisfaction associated with a cash reward depends on recently-obtained rewards and satisfaction ratings.

The first analysis examined the effects of previous rewards on the satisfaction rating given by participants to a current reward. Due to the randomization of the presentation of stimuli, stimuli were not correlated with previous stimuli. Therefore, simple zero-order correlations between the current satisfaction rating and each of the previous five reward values were calculated for each participant individually and the resulting values subjected to analysis. The mean results are shown in Figure 4a, where it can be seen that sequential effects were indeed evident – there was a negative correlation between current satisfaction rating and preceding reward values. The correlations between current satisfaction rating ( $S_n$ ) and previous rewards  $R_{n-1}$ ,  $R_{n-2}$ , and  $R_{n-4}$  were all significantly different from zero ( $p < .001$  in all cases); the correlation between  $S_n$  and  $R_{n-3}$  was also significant but only at  $p = .027$  and should therefore be treated with caution due to the multiple comparisons being undertaken. There was therefore a small but clearly significant sequential-contextual effect – the satisfaction expressed by participants with a given reward is negatively related to the size of rewards they have received on recent trials. The correlations for individual participants were entered into a  $5 \times 4 \times 2$  (5 lags  $\times$  4 distributions  $\times$  2 reward size) ANOVA. The results revealed no significant effect of lag or any significant interaction between lag and distribution and reward size.

Because the reward distributions were skewed by design, we repeated the above analyses using non-parametric measures of correlation (Spearman's Rho, and the Gamma coefficient). A qualitatively identical pattern of results was obtained.

A separate set of analyses examined possible effects of previous satisfaction ratings on current satisfaction ratings. Partial autocorrelations were calculated for each participant, such that the effect of each previous satisfaction rating  $S_{n-k}$  on the current satisfaction rating  $S_n$  was available when the effect of more recent satisfaction ratings ( $S_{n-j}$  when  $j < k$ ) were partialled out. The partial autocorrelations are shown in Figure 4b. The correlations of  $S_n$  with  $S_{n-2}$ ,  $S_{n-3}$  and  $S_{n-4}$  were all significant ( $p < .001$  in all cases) while the correlation of  $S_n$  with  $S_{n-5}$  was significant at the .05 level. The correlation between  $S_n$  and  $S_{n-1}$  did not approach significance ( $p > .10$ ).

Results from a  $5 \times 4 \times 2$  ANOVA revealed a significant effect of lag:  $F(4,200) = 2.681$ ,  $p < .05$ ; and a significant difference in distributions:  $F(3,50) = 3.506$ ,  $p < .05$ . Post hoc test showed a mean difference of 0.06,  $p < .05$ , between correlations for the end-skewed distribution and the low-range distribution. There was no effect of reward size, and no significant interactions of any combination.

Model-based Analysis. Further analysis was undertaken to determine whether RFT provided a good fit to the results. We fit the data with the RFT model (Equation 3) in the same fashion as in Investigation 1. We first obtained the best-fitting weighting parameters for each condition, and calculated the corresponding  $R^2$  values – these are listed in Table 10. The model comparison logic was identical to that used in the analysis of Experiment 1. Significant extra variance was accounted for by the full RFT model compared with a model in which only the position of reward within range was used to predict satisfaction ( $\chi^2(1) = 42.6$ ;  $p < .001$ ) and compared with a model in which only the ordinal position of each reward within the rank-ordered set was used to predict satisfaction ( $\chi^2(1) = 111.4$ ;  $p < .001$ ). It is evident from the parameter values that the effects of distribution (rank-dependence) were substantially greater in Investigation 1 than in Investigation 3, and this is assumed to reflect the difference between simultaneous and sequential presentation (with the overall distribution being more salient to participants in the former case). Nevertheless, significant additional variance is accounted for by RFT in both cases.

The above analysis has implicitly assumed that the psychological magnitudes of wages, prior to rating, are a linear function of actual wage amount. We considered the possibility that including a non-linear transformation of wage amounts would improve the fit of the model. A significantly better overall fit was obtained when a power-law transformation was included ( $\chi^2(1) = 98.1$ ;  $p < .001$ ) and the fit was better

yet when the exponent of the power-law transformation was allowed to vary between “high reward” and “low reward” conditions ( $\chi^2(1)=28.4$ ;  $p < .001$ ). The advantage of the full RFT model over the model restricted to range-values only and to rank-value only remained significant ( $\chi^2(1)=29.9$ ;  $p < .001$ ; and  $\chi^2(1)=69.4$ ;  $p < .001$ , respectively). The parameter values and  $R^2$  values are shown in Table 10.

### Discussion

The results of this third investigation provide further evidence consistent with the view that the satisfaction from a reward is context-dependent. In Investigation 3 we extended the notion of context to include sequential effects. The results were consistent with the suggestion that reward satisfaction ratings, at least within an experimental context, are determined partly by comparison with other, recently-presented, rewards. A given level of reward produces a higher satisfaction rating if lower rewards have been received and rated in the recent past. Furthermore, consistent with the rank-dependent hypothesis, RFT provided a reasonable account of the overall ratings given to rewards when the distribution as a whole is taken into account. Of course it is undoubtedly the case that the experimental methods used in Investigations 1 and 3 are likely to have encouraged participants to rate their satisfaction on a relative basis. The main contribution of these investigations is to provide some evidence, consistent with the program of economic psychophysics, that similar principles (context-dependence in general and rank-dependence in particular) apply to judgments of economic quantities such as wage satisfaction as well as to simple psychophysical stimuli.

### **Overview Remarks**

The central conclusion to emerge from the investigations concerns the importance of rank-dependence in wage satisfaction. The implications are wide. We note that the rank-dependent approach offers the possibility of accounting for otherwise puzzling phenomena. For example, consider an experiment varying distribution of rewards received. In condition 1, subjects receive 50p on 90% of trials and 20p on the remaining 10% of trials. In condition 2, subjects receive 50p on 90% of trials (just as in the first condition) but on the remaining 10% of trials they receive 80p. Empirical observation (Parducci, 1968, 1995) suggests that subjects in the first condition will rate themselves as more content at the end of the experiment than will

participants in the second condition, even though the total amount of money they have received, and the average earnings per trial, are lower. RFT offers a straightforward account of findings such as this – intuitively, the idea is that in the first condition participants are most of the time being rewarded at the upper end of their expectations. RFT principles make clear how this will lead to greater satisfaction (see Parducci, 1968, 1995, for quantitative developments).

An additional issue concerns the relation between utility and wealth or income under rank-dependence. It is evident that a rank-dependent component of utility, combined with a positively-skewed distribution of incomes or resources, will lead to a utility function that is concave-downward for most of its range (as in the results of Investigation 1). For example, consider the case when the majority of incomes within a community are relatively low with respect to the overall range of incomes in that community, as in the normally-observed case of positively skewed incomes. Under such circumstances a given absolute increase in a relatively low income will lead to greater progress up the rank ordered set of incomes than will the same increase when applied to a relatively high income. This is illustrated in Figure 5. Figure 5a shows the positively skewed income distribution of a hypothetical community, and Figure 5b shows the function relating utility to income that would obtain in that community if utility was solely rank-dependent. The concavity of the function will decrease (and change from a cumulative probability function to a straight line) to the extent that utility depends on absolute income in addition to ranked position, and will increase with amount of positive skew in the community income distribution. Indeed, Investigation 1 found evidence consistent with concave-upwards utility in a context of negatively skewed incomes. Given the tendency for large amounts to be rarer than small amounts, both for economic quantities such as incomes, assets, or financial settlements, and in the natural world more generally (see e.g., Bak, 1997; Chater & Brown, 1999; Schroeder, 1991) we speculate that rank-dependence may be one factor underlying the typically-observed downward concavity of utility functions.

The perspective we have presented, although derived from psychology, has some points of similarity with rank-dependent accounts developed in within economics and at the interface between economics and psychology. As we noted in the introduction, influential accounts of decision making, such as prospect theory (Kahneman & Tversky, 1979), rely on the notion of a single reference point in relation to which outcomes are assessed as gains or as losses. The reference point may

be seen as current endowment or as customary consumption (see e.g. Munro & Sugden, 2003, for discussion and an alternative reference-point model). Lim (1995) suggests that RFT principles can be used to derive a single reference point. Such accounts contrast with RFT's emphasis on multiple reference points.

However the class of rank/sign dependent utility theories (RDSU) (e.g. Quiggin, 1982; Schmeidler, 1989) and the rank-dependent extension of prospect theory (cumulative prospect theory: Tversky & Kahneman, 1992) incorporate rank-dependence into the assessment of lotteries (see Diecidue & Wakker, 2001, for an intuitive justification). They therefore allow that differential weighting may be attached to outcomes as a function of the relative rank of the attractiveness of such outcomes. More specifically, RDSU accounts frame outcomes within a lottery in terms of cumulative probabilities, and weighting may thus given to the probability of doing "at least as well as" or "at least as badly as" some outcome. Individual differences (such as pessimism and optimism) may thereby be incorporated into such accounts (Weber & Kirsner, 1997). The notion of aspiration level forms an additional component of the SP/A theory (Lopes, 1987; see Lopes & Oden, 1995, for a discussion of the relation between cumulative prospect theory and SP/A theory).

Thus developments in RDU are related to the account we have developed here in terms of their emphasis on rank-dependence as a particular type of context-dependence. However the area of application of RSDU (lottery evaluation) is very different from the present application of RFT, and there is no straightforward way to extend the machinery of rank-dependent utility to cases like wage satisfaction. The concern in modelling wage satisfaction case is with the evaluation of a single outcome, rather than with a set, of outcomes, and weighting is of outcomes rather than cumulative probabilities. Moreover, a fundamental difference between rank-dependence in RFT and in RDSU theories relates to the notion of *coalescing*. In the case of complex lotteries, coalescing is the idea that common outcomes can be amalgamated — two probabilities of a given gain can be coalesced into a single larger probability of the same gain. Original prospect theory included editing rules to allow this (Kahneman & Tversky, 1979) but coalescing is implicit in rank-dependent utility theories (see e.g. Birnbaum & Navarrete, 1998; Birnbaum, Patton, & Lott, 1999). However there can, contrary to the assumption of coalescing, be effects of event-splitting (Humphrey, 1995; Starmer & Sugden, 1993). Birnbaum and his colleagues have argued that RDSU models as a general class are problematic in that they fail to

allow violations of stochastic dominance, yet such violations can be reliably. Configural weighting theory, in contrast, (Birnbbaum, 1973, 1974) which assigns rank-dependent weightings to events but allows violations of stochastic dominance, appears do a better job of accounting for the data; Birnbbaum et al. (1999) highlight the role of coalescing in particular. It is important to note, therefore, that RFT, like configural weighting theory, allows violations of coalescing – if an event with a given probability is split into two events of lower probability, then the ordered position (and hence evaluation) of more favourable outcomes would be expected to change. There are thus several crucial differences between the perspectives of RFT and of RDSU. However, further work is needed to achieve a reconciliation of the various perspectives alluded to here.

### **Conclusion**

The purpose of this paper has been to argue that economists' textbook models are too simple. Workers do not care solely about their absolute level of pay, nor are they concerned solely with their income relative to the average remuneration around them. Human beings' feelings are more subtle than that: to understand what makes workers satisfied it is necessary to look at the distribution of wages inside a workplace.

Rank matters to people. They care about where their remuneration lies within the hierarchy of rewards in their office or factory. They want, in itself, to be high up the pay ordering.

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**Table 1. Annual Wages Used in Six Distributions in Investigation 1**

Pos skew	17.2	17.6	18.1	18.7	19.5	20.3	21.4	22.7	24.3	26.1	28.4
Neg skew	17.2	19.5	21.3	22.9	24.2	25.3	26.1	26.9	27.5	28.0	28.4
Unimodal	17.2	20.0	21.5	22.2	22.6	22.8	23.0	23.4	24.1	25.6	28.4
Bimodal	17.2	17.4	17.8	18.5	20.0	22.8	25.6	27.1	27.8	28.2	28.4
Low Range	14.3	17.1	18.6	20.0	21.4	22.8	25.9	26.8	27.5	28.0	28.4
High Range	17.2	17.6	18.1	18.8	19.7	22.8	24.2	25.6	27.1	28.5	31.3

Note: 17.2 means a value of £17,200 pounds sterling

**Table 2: Background Measures Included as Variables in All Regressions**

Measure
Age
Employer size
Temporary job
Education
Gender
Race
Union recognition
Occupation (SOC Code at the one-digit level)
Industry (SIC code at the two-digit level)
Region
Hours worked
Marital status

**Table 3**

**Correlation matrix (no sample weights) among the following variables:  
Employee's Satisfaction with Influence over the Job; Satisfaction with Pay;  
Satisfaction with Achievement; Satisfaction with Supervisors' Respect; Log of  
Pay; Log of Mean Pay; the Rank measure of Pay; the Range measure of Pay.**

**14703 observations**

	<i>Influence</i>	<i>Pay</i>	<i>Achievement</i>	<i>Respect</i>	<i>Ln(pay)</i>	<i>Ln(mpay)</i>	<i>Rank</i>	<i>Range</i>
Influence	1.000							
Pay	0.339	1.000						
Achievement	0.523	0.312	1.000					
Respect	0.523	0.348	0.499	1.000				
Ln(pay)	0.041	0.083	0.021	-0.021	1.000			
Ln(mpay)	0.005	0.062	-0.021	-0.030	0.680	1.000		
Rank	0.095	0.119	0.086	0.046	0.643	0.042	1.000	
Range	0.072	0.116	0.072	0.024	0.673	0.134	0.801	1.000

**Correlation matrix (sample weights)**

**14703 observations**

	<i>Influence</i>	<i>Pay</i>	<i>Achievement</i>	<i>Respect</i>	<i>Ln(pay)</i>	<i>Ln(mpay)</i>	<i>Rank</i>	<i>Range</i>
Influence	1.000							
Pay	0.337	1.000						
Achievement	0.532	0.309	1.000					
Respect	0.538	0.347	0.514	1.000				
Ln(pay)	0.027	0.062	0.009	-0.046	1.000			
Ln(mpay)	-0.005	0.058	-0.030	-0.060	0.698	1.000		
Rank	0.090	0.089	0.090	0.052	0.636	0.072	1.000	
Range	0.070	0.092	0.081	0.030	0.653	0.142	0.792	1.000

**Table 4a. Satisfaction Equations (in four domains) with Absolute Pay as an Independent Variable. Standard errors in parentheses.**

<i>Regressor</i>	<i>Influence</i>	<i>Pay</i>	<i>Achieve</i>	<i>Respect</i>
Ln(pay)	0.128 (0.021)	0.556 (0.026)	0.119 (0.021)	0.057 (0.022)
Observations				
Workplaces	1744	1744	1744	1744
Individuals	21862	21862	21862	21862
Log-L	-28167.4	-30237.5	-28294.2	-30508.6
Pseudo R <sup>2</sup>	0.065	0.116	0.086	0.063

**Table 4b.**

<i>Regressor</i>	<i>Influence</i>	<i>Pay</i>	<i>Achieve</i>	<i>Respect</i>
Ln(pay)	0.144 (0.026)	0.577 (0.034)	0.127 (0.026)	0.084 (0.028)
Observations				
Workplaces	897	897	897	897
Individuals	14703	14703	14703	14703
Log-L	-18830.8	-20229.4	-18943.2	-20351.7
Pseudo R <sup>2</sup>	0.070	0.127	0.090	0.064

**Table 5. Satisfaction Equations (in four domains) with Pay and Mean Pay as Independent Variables.**

<i>Regressor</i>	<i>Influence</i>	<i>Pay</i>	<i>Achieve</i>	<i>Respect</i>
Ln(pay)	0.171 (0.026)	0.554 (0.033)	0.159 (0.027)	0.115 (0.029)
Ln(mean pay)	-0.092 (0.035)	0.077 (0.041)	-0.108 (0.034)	-0.105 (0.038)
Observations				
Workplaces	897	897	897	897
Individuals	14703	14703	14703	14703
Log-L	-18826.2	-20226.1	-18936.9	-20345.7
Pseudo R <sup>2</sup>	0.071	0.127	0.091	0.065

**Table 6a. Satisfaction Equations (in four domains) with Pay, Mean Pay, Rank and Range as Independent Variables.**

Regressor	Influence	Pay	Achieve	Respect
Ln(pay)	-0.013 (0.040)	0.297 (0.048)	0.047 (0.040)	0.010 (0.042)
Ln(mean pay)	0.086 (0.046)	0.319 (0.059)	-0.000 (0.046)	0.000 (0.050)
Rank	0.359 (0.062)	0.356 (0.071)	0.215 (0.066)	0.256 (0.066)
Range	0.065 (0.063)	0.244 (0.069)	0.041 (0.064)	-0.015 (0.064)
Observations				
Workplaces	897	897	897	897
Individuals	14703	14703	14703	14703
Log-L	-18803.1	-20185.7	-18928.6	-20335.9
Pseudo R <sup>2</sup>	0.074	0.133	0.093	0.067

**Table 6b. Satisfaction Equations (in four domains) with Pay and Rank as Independent Variables**

Regressor	Influence	Pay	Achieve	Respect
Ln(pay)	0.047 (0.032)	0.517 (0.039)	0.053 (0.031)	0.008 (0.032)
Rank	0.316 (0.048)	0.196 (0.051)	0.238 (0.048)	0.247 (0.050)
Observations				
Workplaces	897	897	897	897
Individuals	14703	14703	14703	14703
Log-L	-18805.6	-20219.5	-18928.9	-20336.0
Pseudo R <sup>2</sup>	0.074	0.128	0.093	0.067

**Table 6c. Satisfaction Equations (in four domains) with Pay and Range as Independent Variables**

Regressor	Influence	Pay	Achieve	Respect
Ln(pay)	0.081 (0.031)	0.516 (0.039)	0.075 (0.031)	0.044 (0.032)
Range	0.198 (0.048)	0.191 (0.054)	0.161 (0.050)	0.127 (0.050)
Observations				
Workplaces	897	897	897	897
Individuals	14703	14703	14703	14703
Log-L	-18821.0	-20220.0	-18936.7	-20347.5
Pseudo R <sup>2</sup>	0.072	0.128	0.091	0.065

**Table 7a.**

**Satisfaction Equations (in four domains) with Pay and Rank as Independent Variables; comparisons are within occupational group.**

Regressor	Influence	Pay	Achieve	Respect
Ln(pay)	-0.033 (0.062)	0.306 (0.076)	-0.036 (0.063)	-0.027 (0.073)
Rank	0.358 (0.078)	0.194 (0.087)	0.297 (0.081)	0.327 (0.080)
Observations				
Workplaces	366	366	366	366
Individuals	4249	4249	4249	4249
Log-L	-5505.8	-5784.3	-5550.2	-5869.7
Pseudo R <sup>2</sup>	0.070	0.143	0.127	0.086

**Table 7b.**

**Satisfaction Equations (in four domains) with Pay and Range as Independent Variables; comparisons are within occupational group.**

Regressor	Influence	Pay	Achieve	Respect
Ln(pay)	-0.020 (0.061)	0.348 (0.072)	-0.071 (0.062)	0.010 (0.072)
Range	0.304 (0.071)	0.092 (0.078)	0.346 (0.072)	0.227 (0.073)
Observations				
Workplaces	366	366	366	366
Individuals	4249	4249	4249	4249
Log-L	-5507.0	-5786.8	-5544.7	-5873.7
Pseudo R <sup>2</sup>	0.069	0.142	0.130	0.084

**Table 8. Tone stimuli used in Investigation Three, with proportion correctly identified.**

Frequency (Hz)	Proportion Identified
400.00	0.504
420.00	0.348
441.00	0.308
463.05	0.214
486.20	0.237
510.51	0.246
536.04	0.235
562.84	0.280
590.98	0.348

**Table 9. Distributions of rewards used in Investigation Three.**

Distribution	Values of reward in each rank position (penny/pound)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Unimodal	1	25	30	35	40	45	50	55	60	65	70	75	99
Bi-modal	1	5	10	15	20	25	50	75	80	85	90	95	99
Low-range	1	32	42	44	46	48	50	56	61	65	67	68	70
High-range	30	32	33	35	39	44	50	52	54	56	58	68	99

**Table 10. Parameter Estimates and R<sup>2</sup> Values from Investigation 3**

Condition	$w$ (linear model)	R <sup>2</sup> (linear model)	$w$ (power- law model)	$a$ (power- law paramete r)	R <sup>2</sup> (power- law model)
Low, Unimodal	.77	.83	0.93	.75	.95
Low, Bimodal	1.0	.99	1.0	.75	.98
Low, Low Range	.68	.98	0.57	.75	.98
Low, High Range	.74	.97	0.82	.75	.97
High, Unimodal	.58	.73	0.69	.45	.97
High, Bimodal	.93	.87	1.0	.45	.98
High, Low Range	.72	.99	0.50	.45	.99
High, High Range	.3	.95	0.49	.45	.95

## Figure Captions

Figure 1. Two hypothetical distributions to illustrate the predictions of rank-dependence.

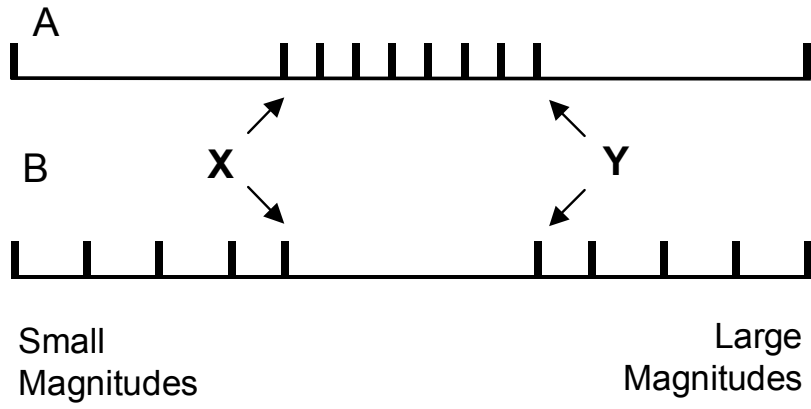
Figure 2. The six stimulus distributions used in Experiment 1.

Figure 3. Data (symbols) and fit of the range-frequency model (solid lines) for the six different distributions used in Experiment 1.

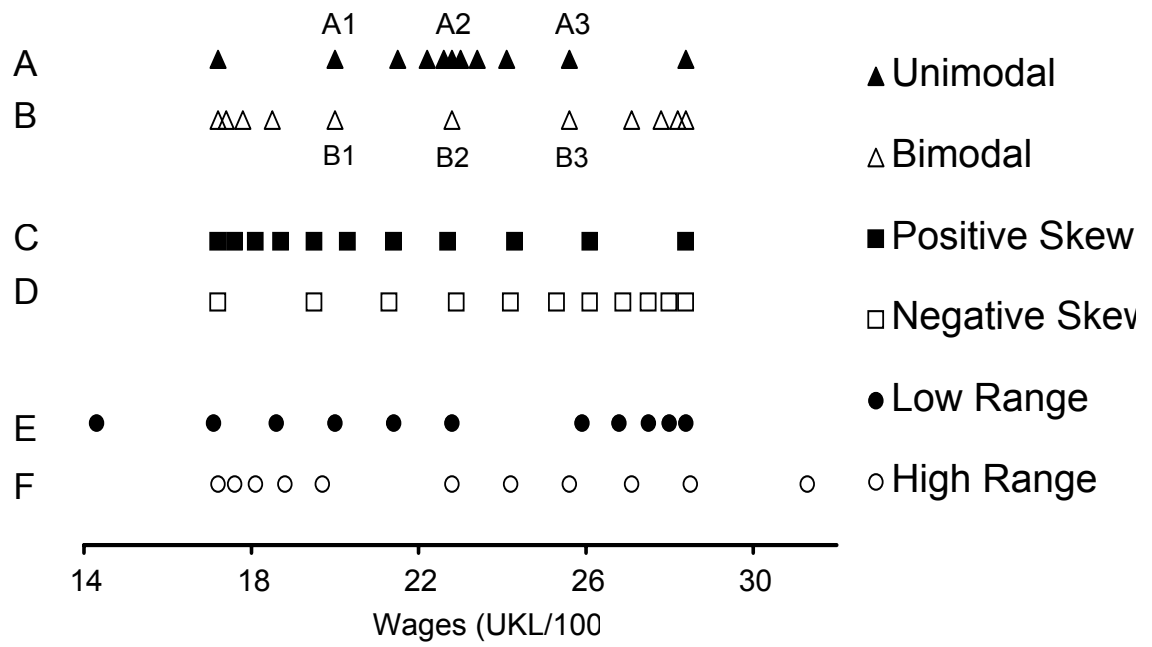
Figure 4. Panel A: Correlations between previous rewards and current satisfaction rating. Panel B: Partial autocorrelations between previous satisfaction ratings and current satisfaction rating.

Figure 5. Panel A: Hypothetical positively-skewed wage distribution. Panel B: Utility function resulting from wage distribution in Panel A if utility is entirely rank-dependent.

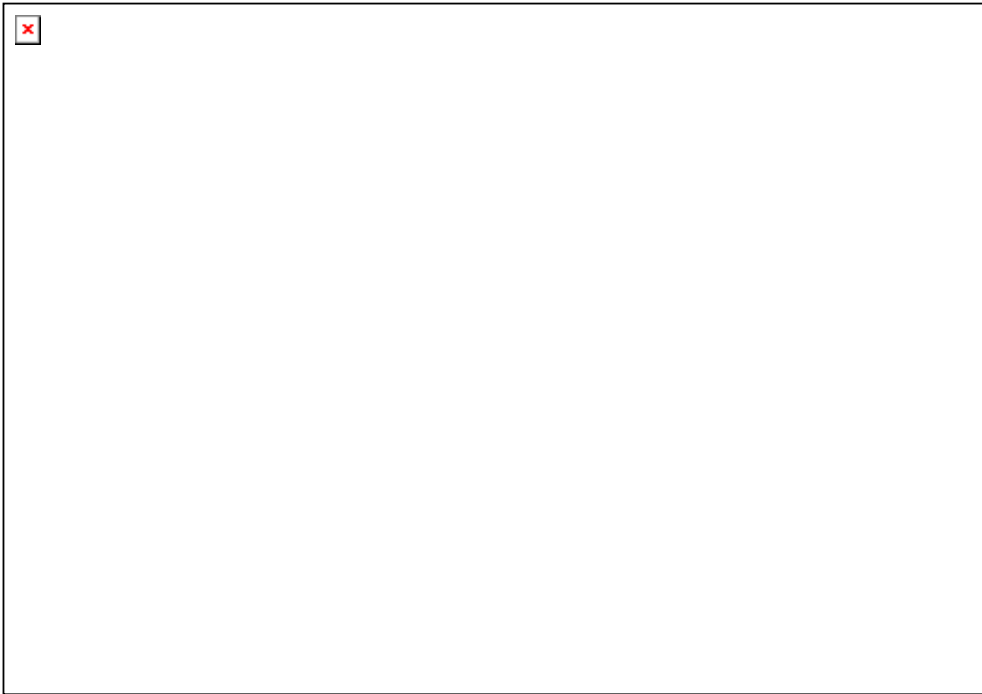
(Figure 1)



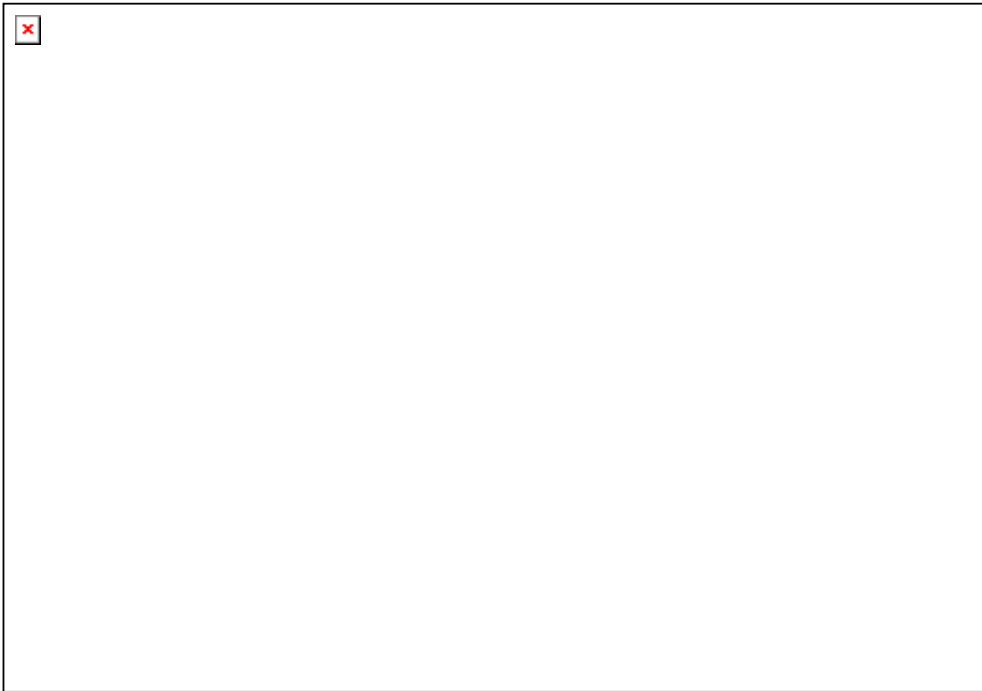
(Figure 2)



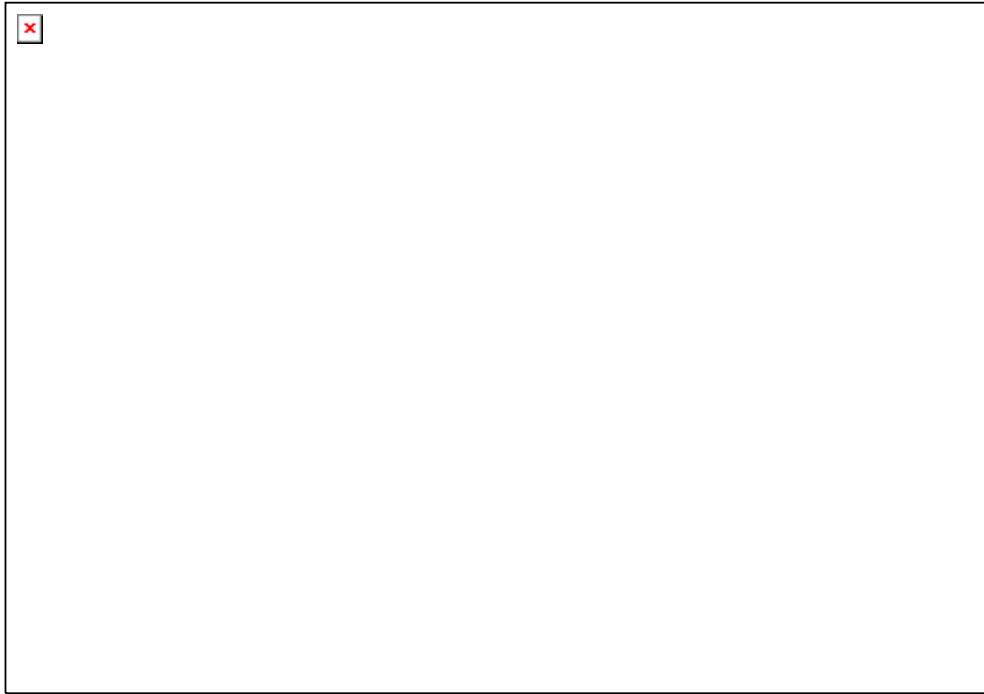
(Figure 3a)



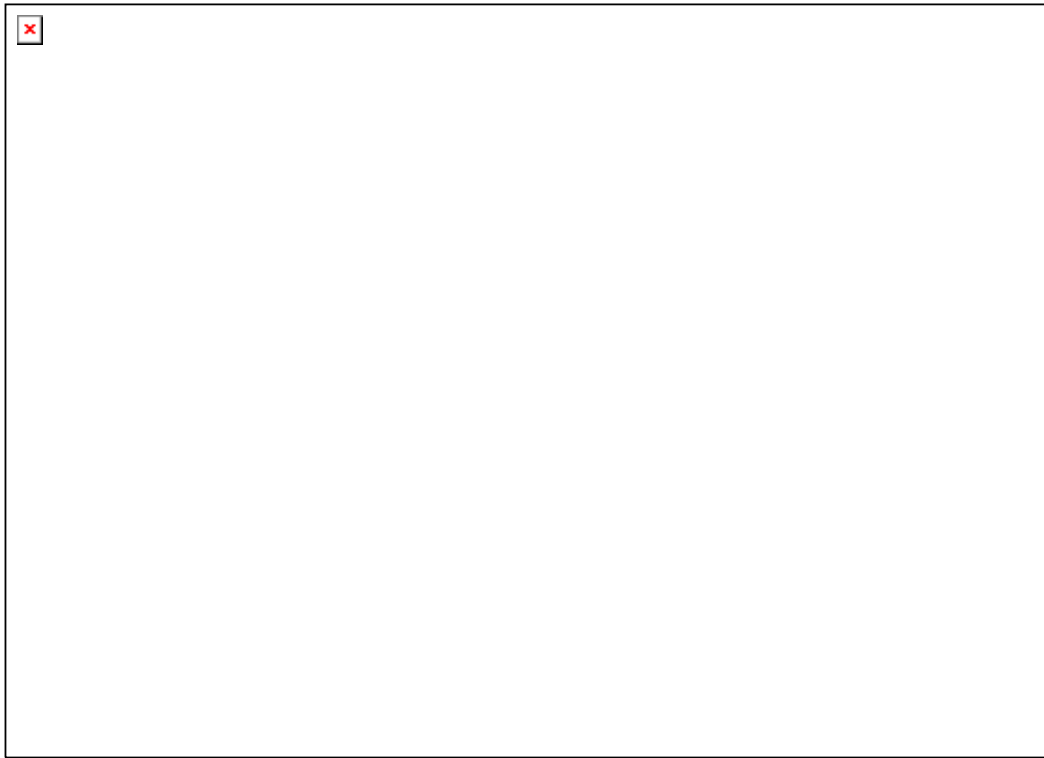
(Figure 3b)



(Figure 3c)



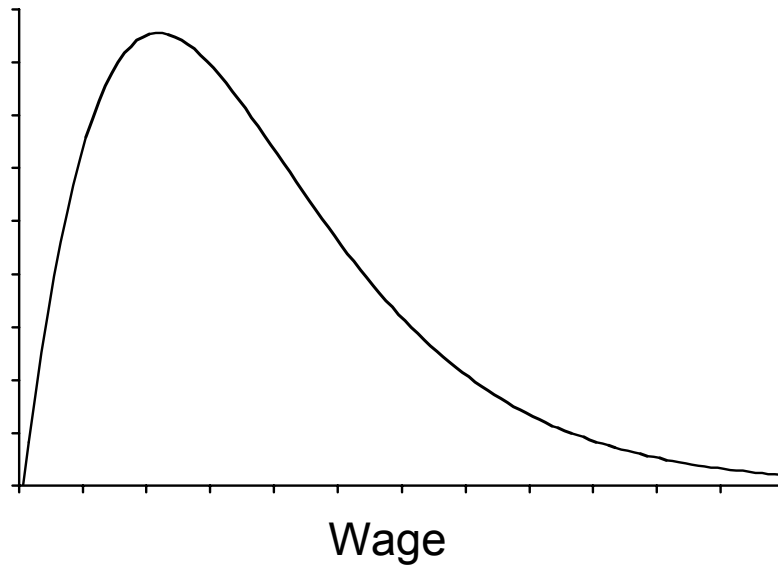
(Figure 4a)



(Figure 4b)



(Figure 5a)



(Figure 5b)

