Abstract

Incommensurability captures an impasse in the decision making process when neither preference nor indifference can be expressed. Past research has linked incommensurability to attribute conflict which occurs when an alternative is very good on one attribute but very bad on another. In decisions with more than one alternative, attribute conflict occurs when each alternative is better than the other on a salient attribute, making it difficult for the decision maker to adequately tradeoff between both alternatives as neither completely dominates the other. In this study, incommensurability was successfully elicited by manipulating attribute conflict in the relative ranks of alternatives. Results suggest relative rank comparisons might be used to resolve decision tasks in some instances, and comparisons between absolute attribute values used in other instances. Results also indicate that indifference can be used as a proxy for incommensurability when people are not allowed to express an inability to choose. This highlights a need for incommensurability to be included as a standard option in decision tasks that elicit tradeoffs.

Keywords: incommensurability, attribute conflict, relative rank theory, attribute spread

An Examination of Incommensurability

1.0 Introduction

In the *Divine Comedy*[1], Dante recounts the story of a man who, standing between two equally desirable foods, is unable to choose and dies of hunger. This character's conundrum captures a phenomenon that is yet to be fully explored in decision making literature. Despite desiring both foods, Dante's character is unable to order them according to his preference, nor is he indifferent between them. If he were indifferent, he would choose at random, and if he could order the foods according to his preference, he would choose the one he most preferred. Rather, the opportunity cost of picking one food over the other is too great, and he is therefore left in a conflicted situation wherein neither choice nor indifference can be expressed. This phenomenon is termed incommensurability (Brown & Walasek, 2016; Chang, 2013; Vlaev, 2011).

Philosopher, Ruth Chang traces incommensurability to the Greek term *asummetros,* used by the Pythagorean brotherhood to capture the relationship between rational and irrational numbers which they (wrongly) believed could not be represented on the same scale. The Pythagoreans gave rise to the concept of incommensurability as a phenomenon that occurs when no cardinal unit of measurement exists to represent the value of two alternatives in relation to each other (Chang, 2013).

In its most basic form, incommensurability exists in the relationship between attributes. Attributes are "basic dimensions of concern" (Fischhoff, 1991) that form the building blocks through which objects are created. For example, a violin (the object) can be represented through its values on the attribute dimensions of tone and durability, while a mug might be represented in terms of volume, shape, and color.

Tradeoffs between objects can be facilitated through artificial scales such as price (Brown

& Walasek, 2016). One could therefore trade a certain amount of mugs for a violin, using monetary value to assess and govern the tradeoff process. Attributes however, are incommensurable because no quantitative scale exists to facilitate tradeoffs between them. Such incommensurability is referred to as qualitative incommensurability and occurs between inherently different characteristics (Vlaev, 2011). For instance, while the shape of a chair might be more important to us than its color (that is, while we can *compare* both attributes), it is difficult to directly *measure* the difference between the color of the chair and its level of comfort. A choice between a red chair or a plastic chair, therefore becomes unresolvable as we have no scale to gauge tradeoffs between the attributes in question.

It is rare that one would be asked to make a direct tradeoff between two unrelated attributes—indeed, such a question might be seen as incomplete and therefore unanswerable. However, incommensurability can also occur in the complex choices decision makers regularly encounter. Unlike qualitative incommensurability which transpires between attributes, quantitative incommensurability[2] occurs in multi-attribute choices wherein alternatives might have similar or identical attribute dimensions. A decision maker, for example, might have to choose between two job offers with varying salaries and commute times, while another might be faced with selecting a suitable mix of bonds and equities for her retirement portfolio.

Attribute spread captures the extent to which the value of such alternatives vary amongst their different attributes. When an alternative is very good on one attribute but very bad on another, it is said to have a large attribute spread. As a result, the decision maker experiences attribute conflict (Coombs & Avrunin, 1976; Fischer, Luce, & Jia, 2000). Although one might easily make tradeoffs involving low attribute conflict—choosing a slightly better paid job over one with a slightly lower commute time—this decision becomes incommensurable when alternatives have high attribute conflict—for example, deciding between a well-paid job with a three-hour commute or a poorly paid job with a ten-minute commute (Deparis, Mousseau, Öztürk, Pallier, & Huron, 2012). Quantitative incommensurability is therefore a product of high attribute conflict between alternatives (Deparis et al., 2012).

Despite the fact that decision makers occasionally face incommensurable tradeoffs, incommensurability has been little explored in decision making literature. Most compensatory models of decision-making assume that (rational) decision makers can always tradeoff different goods and quantities (Payne, Bettman, & Johnson, 1988), while non-compensatory models imply that decision makers adopt strategies to avoid tradeoffs altogether (Pitz, 1977). However, as illustrated by Dante's character, people do not always have a clear preference, nor can they always make a choice, even when presented with full information about the choice set. This paper therefore aims to explore incommensurability with the goal of testing and formalizing conditions under which quantitative incommensurability can be elicited in multi-attribute choices.

2.0 Incommensurability in Non-Compensatory Models

Incommensurability can be characterized as preference uncertainty, linked to lack of confidence in one's ability to make a satisfactory or optimal choice (Deparis et al., 2012; Fischer et al., 2000). Such uncertainty could lead decision makers to avoid making direct tradeoffs (Baron & Spranca, 1997). Tradeoff avoidance is captured in non-compensatory models that suggest people are likely to order attributes in terms of importance or salience and then favor alternatives which are superior on such attributes (Einhorn, 1970; Fischer, Carmon, Ariely, & Zauberman, 1999; Slovic, 1995; Tversky, Sattath, & Slovic, 1988). For example, the elimination by aspects model (Tversky, 1972) indicates choice is based on a sequential elimination process, using weighted attributes (or aspects) to eliminate alternatives. Under this model, attributes are randomly selected to guide the elimination process, and expressed preferences might be inconsistent depending on the order in which attributes are selected.

Similar to the elimination by aspects model, the conjunctive model suggests that an alternative will be selected if it reaches a specific minimum threshold on salient attributes (Payne, 1976). On the other hand, the disjunctive model suggests that an alternative can be selected based on its ability to surpass a maximum threshold on a single attribute (Einhorn, 1970). Likewise, the influential cognitive model of decision making, decision field theory, posits deliberation as a system that accumulates evidence in favor of each alternative. The first alternative to reach a required level of evidence is then selected (Busemeyer & Townsend, 1993).

A series of experiments by Slovic (1975) also reveal that people can resolve conflict in multi-attribute choices by simply choosing the alternative which occupies a higher value on the most important attribute. This process—termed the prominent attribute effect—as well as those outlined in the above non-compensatory models, are easy to justify precisely because they avoid tradeoffs. However, such models are inapplicable when attributes are likely to be equally weighted. Imagine you're attempting to purchase a vacation property. Perhaps you're a fan of modern Nordic design and therefore favor properties with ample natural light and a large number of bedrooms. Left to choose between two cabins that score equally highly in terms of bedroom count and amount of natural light received, models such as elimination by aspects would be unable to facilitate your decision because their processes cannot accommodate equally valued alternatives on equally weighted attributes.

Notwithstanding the limitations of such non-compensatory models, their very existence evidences the notion that decision makers can occasionally face decision tasks with difficult tradeoffs, and opt to resolve the task in a way that avoids tradeoffs altogether. Tradeoff avoidance in non-compensatory models therefore, in an indirect manner, evidences incommensurability.

3.0 Incommensurability in Compensatory Models

In the nineteenth century, scientists attempted to prove that humans have an internal scale calibrated to measure basic perceptual properties (Luce & Green, 1978). This movement—termed the "new psychophysics" (Stevens, 1960)—failed. Not only did people find it extremely difficult to measure properties such as loudness, their experiences of such properties were highly context dependent and could be modified based on other (irrelevant) attributes (Garner, 1954; Laming, 1997; Stewart & Chater, 2003).

Most compensatory models sidestep incommensurability by implying the existence of an internal scale upon which all choice attributes can be valued and traded in terms of utility (Read, 2007; Stewart, Chater, & Brown, 2006; Vlaev, Chater, Stewart, & Brown, 2011). For example, the multi attribute utility theory weights attribute values based on expected utility. This utility is then aggregated across attribute dimensions and the alternative with the highest utility is chosen (Slovic, Fischhoff, & Lichtenstein, 1977; von Winterfeldt & Fischer, 1975). Likewise, prospect theory which is renowned for advancing the insight that value is relative, also posits utility as a psychological unit through which even probabilistic outcomes can be traded (Kahneman & Tversky, 1984).

By using utility as a proxy for value, compensatory models limit decision processes to result in either preference (one alternative has a higher utility than the others), or indifference (all alternatives are equally valued) (Slovic, 1975). However, neither preference nor indifference can serve as proxies for incommensurability. Although indifference and incommensurability deal with equally desirable alternatives, indifference is expressed when the decision maker can easily tradeoff between alternatives. Incommensurability, on the other hand, is expressed when the decision maker perceives this tradeoff as difficult or unresolvable.

The use of uility also implies that decision makers can intuitively measure the value of an alternative, and as a result, should be able to make stable tradeoffs between alternatives, regardless of the decision making context (Pitz, 1977). A participant in a contingent valuation exercise, for example, who indicates the utility associated with paying a $500 fee is higher than the utility of receiving $500 as well as a mild electric shock, should maintain this preference order even when a third alternative—receiving $4,000 as well as the electric shock—is added to the choice set. However, as discussed earlier, psychophysical evidence indicates that people find it cognitively difficult to systematically evaluate basic perceptual properties (Stewart & Chater, 2003). If people cannot measure the absolute loudness of a sound or brightness of a lamp, then it is not unreasonable to expect this difficulty will be manifested in multi-attribute choices characterized by qualitatively incommensurable attributes.

Tradeoff inconsistencies are well documented in the literature (see Starmer, 2000 for an overview). People cannot consistently trade between money and pain (Vlaev, Seymour, Dolan, & Chater, 2009), their willingness to pay to avoid aversive stimuli can be influenced by random contextual anchors (Ariely, Loewenstein, & Prelec, 2003), and their evaluation of an alternative is often influenced by other alternatives in the choice set (Bhatia, 2016; Tsetsos, Usher & Chater, 2010; Vlaev, Chater, & Stewart, 2007).

Decision makers also do not necessarily evaluate multi-attribute decision tasks by combining the utility of each attribute value across (incommensurable) attribute dimensions and then enforcing a tradeoff. In a classic experiment by Tversky and Kahneman (1981), participants revealed they were willing to take a 20-minute trip to save $5 on a $15 calculator but would not make the same trip to save the same amount on a $125 jacket. That is, they evaluated the monetary attributes of both choices separately from the temporal attributes, as opposed to directly measuring a tradeoff between both monetary and temporal attributes on the same utility-based scale, which would have led them to express a stable preference regardless of the cost of the items—either they would have been willing to travel 20 minutes to save $5 or not. Such inconsistencies imply that people either do not have internal scales that facilitate tradeoffs between otherwise incommensurable attributes, or if such scales do exist, access to them is certainly limited. The use of utility as a proxy for value is therefore an inherently flawed aspect of many compensatory models.

It is necessary to be clear that utility occupies a vital space in decision making research. The value of decision making models lies in their ability to predict choice. To that end, it is imperative to understand how value might be represented in cognitive systems. Evidence exists that the brain can compute and encode the value of objects, even if such computations are subjective. Neuroscience research indicates that the ventromedial prefrontal cortex in the brain which is involved in all goal directed choices, can be activated by concrete rewards such as money, and also carries out subjective value calculations of such rewards (Fehr & Krajbich, 2014; Tricomi & Sullivan-Toole, 2015). Cognitive processes can therefore calculate value.

However, those processes are likely not directly reflected in our expressed preferences (Brown & Walasek, 2016). Indeed, the notion that we are strangers to our unconscious cognitive processes is an active area in psychological research (Baumeister, 2005).

4.0 Relative Rank Based Incommensurability

So far, three threads of thought have been advanced; first, qualitative incommensurability suggests direct tradeoffs cannot be made between attribute dimensions. Second, neuroscience research has established that cognitive processes do compute value. Third, expressed preferences are generally context-dependent.

The relative rank theory (Brown & Walasek, 2016) weaves these threads into a model of decision making. Drawing from the decision by sampling theory which indicates value is rooted in comparison (Stewart et al., 2006), relative rank theory suggests that while our higher cognitive processes might be able to perceive the absolute values of incommensurable attribute dimensions, we have limited access to such processes. Rather, our direct choices are measured through context dependent comparisons, and expressed in terms of relative ranks—how good or bad an alternative is, compared to others in the choice set. When normalized to lie between 0 - 1, the relative rank of an alternative reflects the number of other alternatives it dominates in the choice set. In relative rank theory the value of an alternative is crafted through a series of binary, ordinal comparisons to other alternatives in memory as well as in the direct choice set being evaluated. Consider the following attribute values in a choice set with three cameras:

Camera	A	B	D
Cost	$700	$500	$1,200
Weight	251g	400g	751g

Their relative ranks can be easily calculated using simple frequency counts to tabulate each comparison that favors an alternative: Camera A costs more than B (+1), and less than D (-1), thus it occupies the middle rank on the attribute dimension of price. It is lighter than both B (-1) and D (-1), and thus occupies the lowest rank on the attribute dimension of weight.

The notion that subjective values are rank dependent has been proven across a range of contexts. Rank-based information is influential as a social norm (Aldrovani, Brown, & Wood, 2015), rank effects have been detailed in judgements about wage satisfaction (Brown, Gardner, Oswald, & Qian, 2008). Psychological research also indicates that people act as though the subjective value of an amount is partly made up of its rank in the choice set. For example, taxi customers tipped higher when offered 20%, 25%, and 30% as suggested tips (defaults) compared to 15%, 20%, and 25% (Haggag & Paci, 2014).

Relative rank theory therefore values alternatives by taking into account their incommensurable attribute dimensions as well as their position relative to other alternatives in the choice set. More importantly, it allows for alternatives to be valued without depending on absolute measurements from cognitive processes decision makers may not have direct access to. As incommensurability is inherently context dependent—two attribute values may have high conflict in one context, and low conflict in another—the theory is a fitting starting point to explore incommensurability in multi-attribute choices.

4.1 Formalizing incommensurability. The above theories lay the groundwork for formalizing incommensurability as follows:

1. Qualitative incommensurability is mitigated through artificial attribute dimensions.

Direct comparisons between alternatives with no immediate shared attributes (the choice between a liter of petrol and a goldfish, for example) must be transferred to a third, commensurable dimension (such as affordability), before a tradeoff can occur.

2. Tradeoffs can therefore only be facilitated within attributes, not between attributes.

3. In multi-attribute decision tasks, it is likely that attribute dimensions will first be ordered in terms of importance or salience, as posited by non-compensatory models. This process could potentially occur through simple binary ordinal comparisons before tradeoffs between attribute values are then considered.

4. Quantitative incommensurability can only occur in multi-attribute choices when shared attribute dimensions are likely to be equally weighted in any iteration of the decision task.

5. As decisions are made by comparing alternatives, quantitative incommensurability is more likely to arise when, given equally weighted attribute dimensions, there is a large attribute spread between the relative ranks of alternatives, which then leads to high attribute conflict.

5.0 Eliciting Incommensurability

Research into incommensurability is limited. Fischer, Luce, and Jia (2000) link attribute conflict to preference uncertainty. Utilizing response times as well as test-retest errors, their research indicates that preference uncertainty resulting from greater attribute conflict is manifested in increased response times. However, in their study, preference uncertainty is taken to represent random variation (potentially due to errors or noise) in the weighting parameters governing tradeoffs among attributes, rather than incommensurability.

Deparis et al., (2012) use the term ‘incomparability’ to capture a conundrum identical to incommensurability—a conflict in the decision making process wherein neither preference nor indifference can be expressed. In an experiment to elicit incomparability (incommensurability) in multi-attribute choices, they first used a complex matching procedure to craft isopreference chains—combinations of attribute values (in this instance, rental values and distances to a city center), that participants valued equally. Attribute spreads within the chains were then systematically varied by manipulating the absolute attribute values (that is, the actual prices and distances) to increase attribute conflict and elicit incommensurability.

Incomparability was expressed in 19% of responses and greater attribute conflict did lead to more reports of incomparability (Deparis et al., 2012). Strikingly, when a similar test was carried out amongst participants who were allowed to express indifference or preference but not an inability to choose, higher attribute conflict was tied to increased use of indifference. These results indicate people can potentially conflate indifference and incommensurability, expressing indifference even when that response does not adequately capture their intentions.

The present study aims to build on the work of Deparis et al., (2012) and develop a relative rank based theory of incommensurability. As the study by Deparis et al., (2012) represents one of few attempts to directly elicit incommensurability in the literature, the present study first aims to replicate that experiment. This study also aims to test incommensurability in an organic manner similar to how it might occur in real-life settings, while allowing for ease of replication in future studies. As such, isopreference chains which arguably add more complexity to the decision tasks, will not be used in this study.

It is hypothesized that incommensurability will arise due to high attribute conflict between alternatives. Attribute conflict will depend on the relative rank spread of each alternative, rather than its direct (absolute) value. Thus, alternatives with high attribute conflict in terms of their relative ranks will be viewed as more incommensurable than alternatives with low attribute conflict (expressed in terms of a low relative rank spread). Low rank spreads are defined as spreads less than .50 on a linear 0 – 1 scale, while high rank spreads are above .50. By extension, it is also hypothesized that alternatives with extreme rank spreads, representing the highest possible attribute conflict, will reflect more instances of incommensurability.

In order to test this hypothesis, participants will be divided into two groups. Each group will undergo a familiarization task wherein they will be exposed to attribute values with two different distribution skews, a negative skew with a higher concentration of larger values, and a positive skew with lower values. Relative rank comparisons depend on the immediate choice set and a sample drawn from previously encountered values (Stewart et al., 2006). After the familiarization task, each distribution skew should perceive the same attribute values as having different relative ranks. For example, suppose each skew were presented with this range of rental values (note that lower numbers represent cheaper rents):

Positive Skew: [1 2 3 5 **7** 10 13 19]

Negative Skew: [1 **7** 10 13 15 17 18 19]

Despite having the same absolute value, Apartment 7 (in bold) might be viewed as cheap by a participant in the negative skew since it occupies a lower relative rank compared to other apartments in the distribution, while the same apartment might be viewed as relatively expensive by a participant in positive skew since it occupies a higher relative rank in that distribution. Exposing participants to two different skews will therefore help parse out the effects of attribute conflict expressed through relative rank spread.

Finally, as indicated by Deparis et al., (2012) it is hypothesized that when incommensurability cannot be expressed, indifference will be used as a proxy to represent decision makers' inability to choose. In order to test this hypothesis, participants will be divided into two groups; an incommensurable group which will be given the option to express preference, indifference, or incommensurability in each decision task, and an indifference group which will be given the option to express preference or indifference in each task.

Method

Participants

200 participants were recruited through Amazon Mechanical Turk (MTurk) and compensated $1 for their participation. Utilizing MTurk ensured a diverse participant pool that would otherwise not have been reached (Ronayne & Brown, 2016). Participants were randomly assigned to the positive or negative skew, and under each skew, to the incommensurable or indifference group.

Materials

Stimuli was an online survey designed and administered through Qualtrics. Though online surveys involve a slight risk that participants may not pay full attention to the survey questions, the experimental setup utilized in this study was crafted to control for this problem. Attribute dimensions used in the experiment were rental prices and standardized bus stop distances between rental units and a city center. Quantitative incommensurability occurs when attributes are equally valued. While Vlaev (2011) discusses the possibility of a commensurability index, no such measure yet exists. However, the use of housing attributes (such as rental values and bus stop distances) in decision tasks is well established in decision making literature (Deparis et al., 2012; Pan & Lehmann, 1993; Simonson, 1989). Table 1 details the attribute values presented to participants in each skew. Participants in both the indifference and incommensurable group could express their choice of an apartment on a continuous scale ranging from slight preference to strong preference and indifference. Participants in the incommensurable group could also express inability to choose. The description given for incommensurability was ‘‘I find it hard to choose between A or B. I can’t say that I prefer them equally, but I also find it difficult to say which one I prefer.’’ The description for indifference was “I'm indifferent between A and B; I would be equally happy with either.” See Appendix for sample questions presented to each group.

[Table 1 about here.]

Procedure

The experiment was divided into two parts. The first was a familiarization task designed to familiarize participants with the distributions of rental values and bus stop distances. Participants were asked to assume they had accepted employment in a new city and would have to rent an apartment which they would share with two friends. This premise, though hypothetical, is arguably meaningful to subjects, utilizing a scenario that many adults will engage in at some point in their lives—finding a place to live. The strategy of telling participants they would be making a decision for themselves and two friends was used to make the decision task seem more realistic, and to also endow participants with a sense of responsibility which would compel them to pay attention to the familiarization task.

Participants were then informed that they would be shown a range of rental values of apartments around the city, as well as bus stop distances between apartments and the city center where they and their friends would be working. Eight rental values and bus stop distances were presented twice in a counterbalanced manner between participants (some participants saw rental values first, while others saw bus stop distances first). Each attribute value was presented individually and participants were instructed to replicate the value they had been shown in order to relay the information to their friends. Example screen-captures are presented in Figures 1a and 1b. Participants were also asked to pay close attention to the displayed values as they might be tested later in the survey. Following the familiarization procedure, participants were asked four questions pertaining to the distribution they had seen. These questions were used as validation checks before analyzing the data (see below).

[Figure 1a about here.]

[Figure 1b about here.]

In the second part of the survey, participants were instructed to choose between two apartments based on their rental cost and distance to the city center. Attribute values were systematically varied in terms of relative rank distance and absolute distance. Participants answered ten questions (see Table 2). Six questions (Q161 – Q164 and Q167 – Q168) varied attribute spread in terms of relative rank, such that the negative skew perceived a different rank spread than the positive skew. Two questions (Q165 – Q166) introduced new rental values and distances in order to explore incommensurability when sampling from memory is restricted. Two questions (Q169 – Q170) served as direct tests of monotonicity. In both questions, one apartment was clearly better than the other.

[Table 2 about here.]

Exclusion Criteria. As it was essential that participants understood the spread of attribute values presented in the familiarization task, a test was used to check participants' grasp of the distributions (see Appendix for the test). Participants were asked four questions which divided the distribution of bus stops and rental values into 75% - 25% splits. For example, question Q73 elicited the number of apartments located 9 - 20 bus stops away from the city center, while Q76 elicited the number of apartments 0 - 11 stops away. Participants in the positive skew were exposed to more apartments (75%) between 9 and 20 stops away from the city center. Thus, participants in that group who adequately understood the distribution would have provided a higher figure in Q73 than in Q76.

Validation checks were carried out using responses to this test as criterion for exclusion. Responses from 45% (*n* = 90) of participants did not indicate that one distribution of stops and rental values was higher than the other. This suggests that the test might have imposed too strict of an exclusion criterion. Questions Q169 and Q170 were also used as a test of monotonicity to further check that participants understood the decision task. In both questions, Apartment A was better across both attribute dimensions. Participants who passed the validation test expressed a preference for apartment A in 77% of responses to Q169 and 96% of responses to Q170. As it was imperative that participants understood the distributions presented to them and responses from the questions designed to test monotonicity further indicated that participants who passed the validation checks actually understood the decision task, the following analyses utilize the results of the participants whose responses passed the validation criteria (*n* = 110). Identical analyses using the results of all 200 participants are detailed in the Appendix.

Out of the remaining 110 participants, 34 participants were exposed to a negative skew, and 76 participants exposed to a positive skew. 22 people in the negative skew were also in the incommensurable group and 28 people in the positive skew group were in the incommensurable group, totaling 50 people in the incommensurable group across both skews. 60 people were in the indifference group across both skews.

Relative Rank Spread. A function was developed using the R program (https://www.r-project.org) which evaluated the relative rank spread (the difference between the relative ranks of each attribute across both apartments) of the bus stops and rental values in each question. Relative ranks of each rental value and bus stop were first represented on a linear scale ranging from 0 - 1, utilizing a simple formula (n represents the number of items in the choice set):

$$Relative\ Rank = \frac{n_{lower}}{n-1} \quad (1)$$

The rank spread between both apartments in each question was calculated by averaging the difference between the relative ranks of bus stops and then of rental values:

$$Overall\ Rank\ Spread = \frac{(Rank_{Rent\ A} - Rank_{Rent\ B}) + (Rank_{Bus\ Stop\ A} - Rank_{Bus\ Stop\ B})}{2} \quad (2)$$

It should be noted that in all questions designed to elicit relative rank based incommensurability, the rank spread within each attribute dimension was identical. The difference between the relative rank of rental value A and rental value B was identical to the difference between the relative rank of bus stop A and bus stop B, such that if there was a high attribute conflict between bus stops, there would be a similar conflict between rental values. This was done to reinforce the equality of attributes. Otherwise, if bus stops, for example, had a lower attribute conflict than rental values, then bus stops could easily have been utilized to facilitate the tradeoff process, thus simplifying the task and eliminating the need to express incommensurability.

Absolute Attribute Spread. The absolute difference between attribute values was calculated in a similar manner to the relative rank spread. Rental values and bus stop distances were converted on a linear scale ranging from 0 – 1. Attribute spread was then calculated by substituting relative ranks with absolute values in the overall rank spread formula above.

Results

[Table 3a about here.]

[Table 3b about here.]

Overall, 21 (7%) responses of incommensurability were recorded by the incommensurable group. The first hypothesis suggested that more responses of incommensurability would be recorded when participants made decisions involving high attribute conflict—reflected in a high relative rank spread, relative to those with a low rank spread. Tables 3a and 3b denote responses based on rank skew across the incommensurable and indifference groups respectively. Table 4 shows the percentage of incommensurability responses across lower and higher rank spreads. Rank spreads are culled from questions designed to elicit incommensurability (Q161 – Q164 and Q167 – Q168). Notice from Table 2 that each question has a different rank spread. Questions with large rank spreads received more incommensurability responses ($M = 8.67$, $SD = 2.82$) relative to the low rank spreads ($M = 5.33$, $SD = 2.25$). This difference is nonsignificant, $\chi^2(1, N = 300) = .42$, $p = .52$, 95% CI [-.05, .11].

[Table 4 about here.]

The first hypothesis also implies that incommensurability should be caused by rank spread rather than attribute spread. Questions with identical attribute spreads but varying rank spreads should therefore yield different responses of incommensurability. The attribute spread for questions Q163 and Q164 is .67. A rank spread of .43 was perceived by the negative skew group in Q163 as well as the positive skew group in Q164. A rank spread of .86 was perceived by the positive group in Q163 and the negative group in Q164 (see Table 2). Across both questions, participants who experienced a rank spread of .43 reported more incommensurability (22%) than participants who perceived the higher rank spread of .86 (12%). This difference is not significant, $\chi^2(1, N = 100) = 2.87$, $p = .09$, 95% CI [-.01, .21].

The attribute spread for questions Q167 and Q168 is .33. A rank spread of .14 was perceived by the negative group in Q167 as well as the positive group in Q168, and a rank spread of .57 was perceived by the positive group in Q167 and the negative group in Q168. Across both questions, participants who experienced a rank spread of .14 reported incommensurability in 4% of their responses. Participants who perceived the higher rank spread of .33 reported incommensurability in 3% of their responses. A simple Fisher's test was carried out for this analysis. This test was selected as appropriate for smaller samples, as in the case of this data. The difference in incommensurability responses between both rank spreads was not significant, $p = 1$ (one tailed Fisher's exact test), 95% CI [.22, 9.42].

The second hypothesis suggests more incommensurability would be expressed in questions with extreme rank spreads. The relative rank spread for Q161 was 1 (the widest spread possible, representing apartments with very high attribute conflict), while the spread for Q162 was .29, representing less conflict. As predicted, there was a significantly higher number of incommensurability responses (16%) to Q161, relative to Q162 (4%), $\chi^2(1, N = 100) = 6.72$, $p = .01$, 95% CI [.03, .21].

The final hypothesis indicates that indifference will be expressed in lieu of incommensurability, when incommensurability cannot be expressed. Figure 2 denotes the proportion of indifference responses across both groups. The indifference group recorded more indifference (*M* = 6.50, *SD* = 6.36) relative to the incommensurable group (*M* = 1, *SD* = 0). This difference was significant, $\chi^2(1, N = 1{,}100) = 5.08$, $p = .02$, confirming the hypothesis.

[Figure 2 about here.]

Discussion

The purpose of this study was to explore the role of incommensurability in multi-attribute tradeoffs. The study first aimed to replicate the results of Deparis et al., (2012) and elicit incommensurability by manipulating the attribute conflict between alternatives. Incommensurability was expressed in 7% of responses by participants in the incommensurable group. As incommensurability has been little explored in decision making literature, these results represent a significant addition to the literature, reinforcing incommensurability as an important concept which can arise in everyday decision tasks—one which warrants more attention.

The study also adopted a relative rank based stance which suggests alternatives are evaluated based on their position (rank) relative to other alternatives in a choice set. It was therefore hypothesized that high relative rank spreads would lead to more incommensurability responses than low rank spreads. Results indicate that while questions with high rank spreads did not yield a significantly different amount of incommensurability responses than questions with low rank spreads, Q161 which had the highest rank spread, also had the most incommensurability responses across both groups and skews. These results indicate that incommensurability is more likely to occur in extreme attribute spreads, and decision tasks with less than extreme attribute conflict are less likely to be perceived as incommensurable.

Additionally, this study attempted to separate the effects of rank spread from absolute attribute spread. The difference between questions with identical attribute spreads but varying rank spreads was not significant. Indeed, Q167 and Q168 which had identical attribute spreads also had almost identical incommensurable responses. The results therefore do not definitively allow for the effect of absolute attribute spread to be separated from relative rank spread. Rather, they indicate participants might alternate between using relative ranks and absolute values to facilitate decision making.

Interestingly, the negative skew condition offered more incommensurable responses (14%) than the positive skew condition (5%). This could evidence a relative rank effect, as prices in the real world are positively skewed—we generally encounter more low prices than high prices in daily life (Stewart et al., 2006). As such, participants in the positive skew condition might have felt more adept contemplating the rental values presented, than those in the negative skew who evaluated higher prices than they might encounter in the real world. Thus, the rental values participants might have encountered outside this study could have biased their understanding of the distributions they experienced, leading the negative skew to express more incommensurability.

Finally, as hypothesized, indifference was expressed in a significantly higher percentage of responses when incommensurability could not be expressed. An inability to choose places decision makers in a situation that is both cognitively tasking and emotionally uncomfortable. Decision makers could therefore utilize indifference to absolve themselves from the discomfort of an incommensurable decision task. This finding calls into question a wide range of studies that allow participants to express indifference without providing an option to express incommensurability, or inability to choose. It also emphasizes the need for both options to be present in any decision task that involves tradeoffs.

Limitations of this study include the potentially harsh exclusion criterion which resulted in the exclusion of 45% of participants from the main analyses. Interestingly, results utilizing data from all participants are relatively similar to those detailed above, with the exception that participants who passed the exclusion criteria expressed incommensurability more often than those who did not, thus lending credence to the validity of the test. Future studies might want to impose less challenging exclusion criterion. Future studies could also focus on incommensurability in extreme attribute spreads, with an eye towards better separating the effect of absolute attribute spreads from relative rank spreads. Results also seem to indicate that monetary value can influence perceptions and be used as a tradeoff avoidance strategy to simplify the decision task. It would therefore be interesting for future incommensurability studies to utilize entirely unfamiliar attributes which are less susceptible to bias, such that past experiences are less likely to influence results.

Incomparability was expressed in 19% of responses in the Deparis et al., (2012) study, and in 7% of responses in this study. This study however, focused on eliciting incommensurability in an organic manner which might be encountered in real-life contexts, and therefore avoided using complex isopreference chains. The Deparis et al., (2012) study also had less participants who evaluated more comparisons (*n* = 18, in the incomparability group, drawn from a population of engineering students at a French university. Participants evaluated 1,006 comparisons). This study had more participants who evaluated less comparisons (*n* = 50 in the incommensurable group, drawn from a diverse adult population. Participants evaluated 500 comparisons). Future studies might however, find it useful to first elicit isopreference chains before eliciting incommensurability.

While the present study has focused on desirable choices, little is known about incommensurability in undesirable choices. Research indicates people are more averse to losses than gains (Kahneman & Tversky, 1979). Thus it would be interesting to see if incommensurability is expressed more often when assessing undesirable alternatives with high attribute conflict, potentially capturing the added emotional distress of making an aversive choice.

To conclude with Dante's character, humans expect to be able to make decisions, as not doing so could both limit our experiences and endanger our survival. This study has attempted to add to the body of literature exploring the limited instances in which decisions cannot be made. The study advances the literature in a few keys ways: first, it has established that incommensurability as a concept can be elicited by increasing the attribute conflict between alternatives in a choice set. It has also established that more instances of incommensurability occur when alternatives occupy extreme positions on attribute dimensions. Finally, it has established that indifference can be used as a proxy for incommensurability. Therefore, the option to express incommensurability should be included as a standard aspect of all decision tasks that include preference or indifference, in order to more accurately represent the possibilities in any decision task.

References

Aldrovandi, S., Brown, G. D., & Wood, A. M. (2015). Social norms and rank-based nudging: Changing willingness to pay for healthy food. *Journal of Experimental Psychology: Applied*, *21*(3), 242.

Ariely, D., Loewenstein, G., and Prelec, D. (2003). Coherent arbitrariness: stable demand curves without stable preferences. *Q. J. Econ.* 118, 73–105.

Baron, J., & Spranca, M. (1997). Protected values. *Organizational behavior and human decision processes*, *70*(1), 1-16.

Baumeister, R. F. (2005). Strangers to ourselves: Discovering the adaptive unconscious. *Journal of Social and Clinical Psychology*, *24*(2), 293-295.

Bhatia, S. (2016). Decision Making in Environments with Non-Independent Dimensions. *Journal of Behavioral Decision Making*.

Brown, G. D., Gardner, J., Oswald, A. J., & Qian, J. (2008). Does Wage Rank Affect Employees' Well-being?. *Industrial Relations: A Journal of Economy and Society*, *47*(3), 355-389.

Brown, G. D., & Walasek, L. (2016). Relative rank theory: preferences, choices, and the inaccessibility of value. Manuscript in preparation.

Busemeyer, J. R., & Townsend, J. T. (1993). Decision field theory: A dynamic-cognitive approach to decision making in an uncertain environment. *Psychological review*, *100*(3), 432.

Chang, R. (2013). Incommensurability (and incomparability). *The international encyclopedia of ethics*.

Coombs, C. H., & Avrunin, G. S. (1977). Single-peaked functions and the theory of preference. *Psychological review*, *84*(2), 216.

Deparis, S., Mousseau, V., Öztürk, M., Pallier, C., & Huron, C. (2012). When conflict induces the expression of incomplete preferences. *European Journal of Operational Research*, *221*(3), 593-602.

Einhorn, H. J. (1970). The use of nonlinear, noncompensatory models in decision making. *Psychological bulletin*, *73*(3), 221.

Fehr, E., & Krajbich, I. (2014). Social preferences and the brain. In Glimcher, P. W., & Fehr, E. (Eds.). (2014). *Neuroeconomics: Decision making and the brain*. *Neuroeconomics: Decision making and the brain*. (pp.215-232). Waltham, Massachusetts: Academic Press.

Fischer, G. W., Carmon, Z., Ariely, D., & Zauberman, G. (1999). Goal-based construction of preferences: Task goals and the prominence effect. *Management Science*, *45*(8), 1057-1075.

Fischer, G. W., Luce, M. F., & Jia, J. (2000). Attribute conflict and preference uncertainty: Effects on judgment time and error. *Management Science*, *46*(1), 88-103.

Fischhoff, B. (1991). Value elicitation: Is there anything in there?. *American psychologist*, *46*(8), 835.

Garner, W. R. (1954). Context effects and the validity of loudness scales. *Journal of Experimental Psychology, 48,* 218-224.

Haggag, K., & Paci, G. (2014). Default tips. *American Economic Journal: Applied Economics*, *6*(3), 1-19.

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American psychologist*, *39*(4), 341.

Laming, D. R. J. (1997). *The measurement of sensation*. London: Oxford University Press.

Luce, R. D., & Green, D. M. (1978). Two tests of a neural attention hypothesis for auditory psychophysics. *Perception & Psychophysics, 23,* 363-371.

Pan, Y., & Lehmann, D. R. (1993). The influence of new brand entry on subjective brand judgments. *Journal of Consumer Research*, *20*(1), 76-86.

Payne, J. W. (1976). Task complexity and contingent processing in decision making: An information search and protocol analysis. *Organizational behavior and human performance*, *16*(2), 366-387.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1988). Adaptive strategy selection in decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*(3), 534.

Pitz, G. F. (1977). Decision making and cognition. In *Decision making and change in human affairs* (pp. 403-424). Springer Netherlands.

Read, D. (2007). Experienced utility: utility theory from Jeremy Bentham to Daniel Kahneman. *Thinking & Reasoning*, *13*(1), 45-61.

Ronayne, D., & Brown, G. D. (2016). Multi-attribute decision by sampling: an account of the attraction, compromise and similarity effects.

Simonson, I. (1989). Choice based on reasons: The case of attraction and compromise effects. *Journal of consumer research*, *16*(2), 158-174.

Slovic, P. (1975). Choice between equally valued alternatives. *Journal of Experimental Psychology: Human Perception and Performance*, *1*(3), 280.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1977). Behavioral decision theory. *Annual review of psychology*, *28*(1), 1-39.

Slovic, P. (1995). The construction of preference. *American psychologist*, *50*(5), 364.

Starmer, C. (2000). Developments in non-expected utility theory: The hunt for a descriptive theory of choice under risk. *Journal of economic literature*, *38*(2), 332-382.

Stevens, S. S. (1960). On the new psychophysics. *Scandinavian Journal of Psychology*, *1*(1), 27-35.

Stewart, N., & Chater, N. (2003). No unified scales for perceptual magnitudes: Evidence from loudness. In *Proceedings of the 25th annual conference of the Cognitive Science Society* (pp. 1116-1121).

Stewart, N., Chater, N., & Brown, G. D. (2006). Decision by sampling. *Cognitive psychology*, *53*(1), 1-26.

Tricomi, E., & Sullivan-Toole, H. (2015). Fairness and Inequity Aversion. In A.W. Toga (Eds.) *Brain Mapping* (pp. 3-8). Waltham, Massachusetts: Academic Press.

Tsetsos, K., Usher, M., & Chater, N. (2010). Preference reversal in multiattribute choice. *Psychological review*, *117*(4), 1275.

Tversky, A. (1972). Elimination by aspects: A theory of choice. *Psychological review*, *79*(4), 281.

Tversky, A., and Kahneman, D. (1981). The framing of deci- sions and the psychology of choice. *Science* 211, 453–458.

Tversky, A., Sattath, S., & Slovic, P. (1988). Contingent weighting in judgment and choice. *Psychological review*, *95*(3), 371.

Vlaev, I., Chater, N., & Stewart, N. (2007). Financial prospect relativity: context effects in financial decision-making under risk. *Journal of Behavioral Decision Making*, *20*(3), 273-304.

Vlaev, I., Seymour, B., Dolan, R., and Chater, N. (2009). The price of pain and the value of suffering. *Psychol. Sci.* 20, 309–317.

Vlaev, I. (2011). Inconsistency in risk preferences: a psychophysical anomaly. *Frontiers in psychology*, *2*.

Vlaev, I., Chater, N., Stewart, N., & Brown, G. D. (2011). Does the brain calculate value?. *Trends in cognitive sciences*, *15*(11), 546-554.

Von Winterfeldt, D., & Fischer, G. W. (1975). Multi-attribute utility theory: models and assessment procedures. *Utility, probability, and human decision making*, *11*, 47-86.

Footnotes

[1]Dante *Paradise,* Canto IV

[2]The term 'quantitative incommensurability' is used in this paper to specifically distinguish between incommensurability due to disparate attributes (qualitative incommensurability), and a mathematically tractable incommensurability between alternatives with common attribute dimensions.

Table 1

Breakdown of Rental Value and Bus Stop Distributions

	Negative Skew								Positive skew							
Rental Values	$510	$1,530	$2,040	$2,550	$2,890	$3,230	$3,400	$3,570	$510	$680	$850	$1,190	$1,530	$2,040	$2,550	$3,570
Bus Stops	19	13	10	7	5	3	2	1	19	18	17	15	13	10	7	1

Table 2

Survey Questions Detailing Rank Skew and Attribute Spread

Question	Apartment A	Apartment B	Rank Spread (Negative Skew)	Rank Spread (Positive Skew)	Absolute Attribute Spread
Q161	$510 rent 19 bus stops away	$3,570 rent 1 bus stop away	1	1	1
Q162	$1,530 rent 13 bus stops away	$2,550 rent 7 bus stops away	.29	.29	.34
Q163	$510 rent 19 bus stops away	$2,550 rent 7 bus stops away	.43	.86	.67
Q164	$1,530 rent 13 bus stops away	$3,570 rent 1 bus stop away	.86	.43	.67
Q165	$1,870 rent 11 bus stops away	$3,400 rent 2 bus stops away	.62	.27	.50
Q166	$2,210 rent 9 bus stops away	$680 rent 18 bus stops away	.49	.63	.50
Q167	$1,530 rent 19 bus stops away	$510 rent 13 bus stops away	.14	.57	.33
Q168	$3,570 rent 7 bus stops away	$2,550 rent 1 bus stop away	.57	.14	.33
Q169	$850 rent 13 bus stops away	$2,040 rent 10 bus stops away	.20	.21	.28
Q170	$1,530 rent 7 bus stops away	$2,040 rent 10 bus stops away	.15	.15	.33

Table 3a

Response Counts from Incommensurable Group (n = 50)

Choice	Negative Group (220 responses)	Positive Group (280 responses)	Mean	*SD*
Incommensurable	16 (3%)	10 (2%)	13.00	4.24
Indifferent	1 (0%)	1 (0%)	1.00	0
Slightly Prefer A	39 (8%)	51 (10%)	45.00	8.48
Slightly Prefer B	40 (8%)	47 (9%)	43.50	4.95
Strongly Prefer A	66 (13%)	70 (14%)	68.00	2.83
Strongly Prefer B	58 (11%)	101 (20%)	79.50	30.40

Note. Percentages reflected in parentheses. Figures reflect responses of participants after applying the exclusion criterion.

Table 3b

Response Counts from Indifference Group (n = 60)

Choice	Negative Group (120 responses)	Positive Group (480 responses)	Mean	*SD*
Incommensurable	-	-	-	-
Indifferent	2 (0%)	11 (2%)	6.50	6.36
Slightly Prefer A	24 (4%)	92 (15%)	58.00	48.08
Slightly Prefer B	34 (6%)	74 (12%)	54.00	28.28
Strongly Prefer A	26 (4%)	170 (28%)	98.00	101.82
Strongly Prefer B	34 (6%)	133 (22%)	83.50	70.00

Note. Percentages reflected in parentheses. Figures reflect responses of participants after applying the exclusion criterion.

Table 4

Percentage of Incommensurability Responses Across High and Low Rank Spreads

	High Rank Spreads					Low Rank Spreads				
Skew	1	.86	.57	Mean	SD	.43	.29	.14	Mean	SD
Positive Skew (*n* = 28)	11	4	0	5	5	4	7	0	4	3
Negative Skew (*n* = 22)	23	14	5	14	2	18	0	5	8	2

Note. High rank spreads represent 300 within group responses including 100 responses to Q161 (rank spread of 1 across both skews), and 50 responses each to Q163, Q167, Q168, and Q164. Low rank spreads represent 300 within group responses including 100 responses to Q162 (rank spread of .29 across both skews) as illustrated in Table 2. Figures reflect responses of participants after applying the exclusion criterion.

Table 5a

Responses of All Participants in Incommensurable Group (n = 101)

Choice	Negative Group (660 responses)	Positive Group (350 responses)	Mean	*SD*
Incommensurable	25 (2%)	10 (1%)	17.50	10.61
Indifferent	6 (1%)	1 (0%)	3.50	3.53
Slightly Prefer A	136 (13%)	65 (6%)	100.50	50.20
Slightly Prefer B	121 (12%)	59 (6%)	90.00	43.84
Strongly Prefer A	209 (21%)	88 (9%)	148.50	85.56
Strongly Prefer B	163 (16%)	127 (13%)	145.00	25.45

Note. Figures reflect responses of all participants before applying the exclusion criterion.

Table 5b

Responses of All Participants in Indifference Group (n = 99)

Choice	Negative Group (410 responses)	Positive Group (580 responses)	Mean	SD
Incommensurable	-	-	-	-
Indifferent	8 (1%)	22 (2%)	15.00	9.89
Slightly Prefer A	79 (8%)	113 (11%)	96.00	24.04
Slightly Prefer B	88 (9%)	84 (8%)	86.00	2.83
Strongly Prefer A	129 (1%)	204 (21%)	166.50	53.03
Strongly Prefer B	106 (11%)	157 (16%)	131.50	36.06

Note. Figures reflect responses of all participants before applying the exclusion criterion.

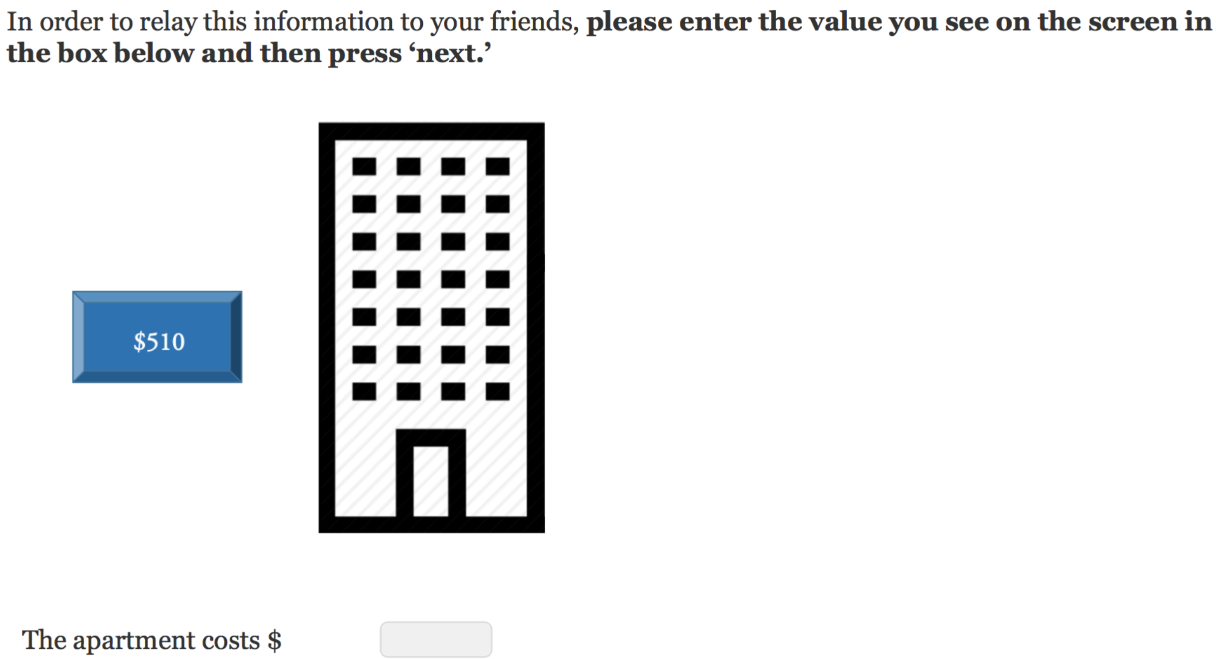


Figure 1a. Screen capture eliciting rental value.

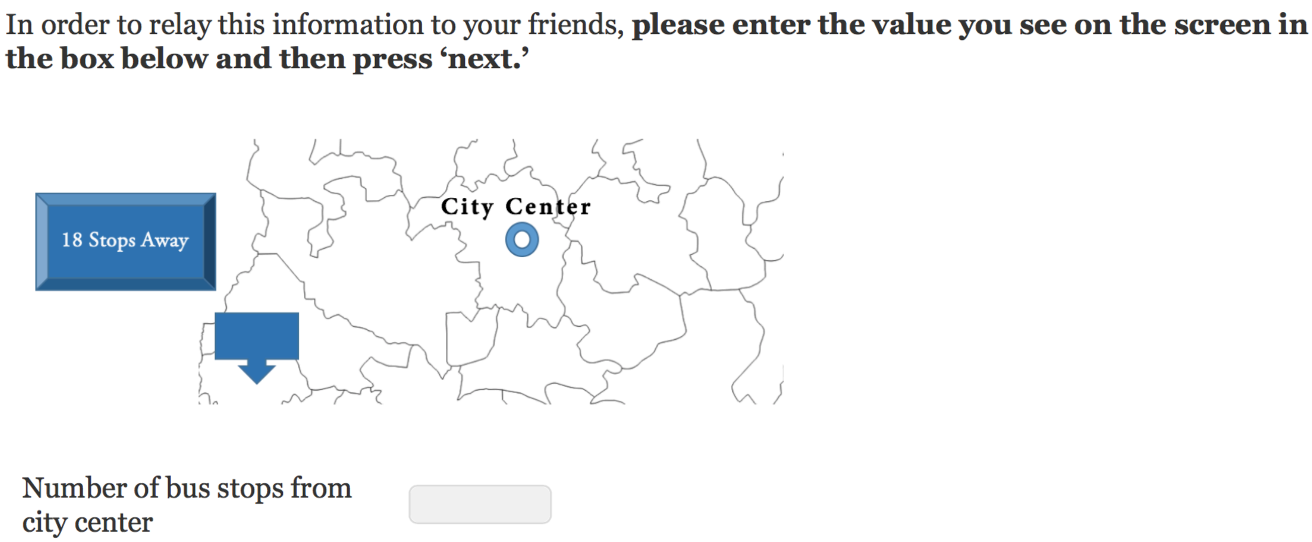


Figure 1b. Screen capture eliciting bus stop distance.

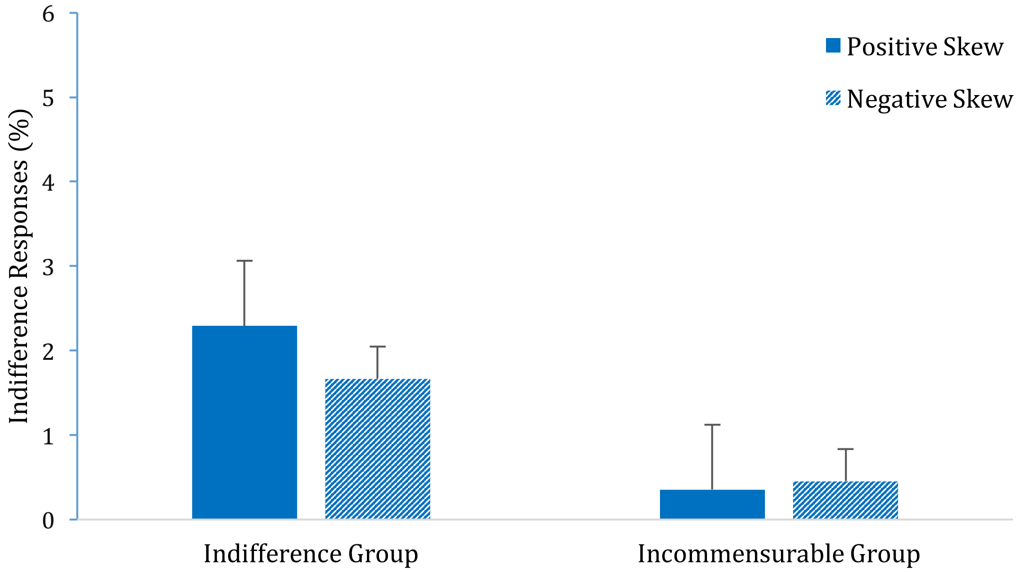


Figure 2. Indifference responses (in percentages) across incommensurable and indifference groups.

Appendix

Results Before Applying Exclusion Criterion (*n* = 200)

Table 5a and 5b reflect responses of the incommensurable and indifference groups respectively. Questions with large rank spreads received a higher percentage of incommensurability responses ($M = 4.9$, $SD = 2.17$) relative to low rank spreads ($M = 3.30$, $SD = 1.79$). This difference is nonsignificant, $\chi^2(1, N = 300) = .13$, $p = .72$, 95% CI [-.04, .08]. While there was a higher number of incommensurability responses (9%) to Q161, relative to Q162 (3%), this difference is also not significant, $\chi^2(1, N = 100) = 2.22$, $p = .14$, 95% CI [-.01, .13].

Data from the larger sample did not support the second hypothesis. There was no significant difference in incommensurability responses to questions Q163 and Q164 which have an identical attribute spread of .67 but different rank spreads .43 (10%) and .86 (13%) respectively, $\chi^2(1, N = 100) = .20$, $p = .66$, 95% CI [-.13, .07]. Likewise, participants recorded the same amount of incommensurable responses across rank spreads of .57 (2%) and .14 (2%) in Q167 and Q168 which had an identical attribute spread of .33.

In line with the third hypothesis, indifference was used more times within the indifference group (3%) relative to the incommensurable group (0%). This difference was significant, $\chi^2(1, N = 2{,}000) = 13.78$, $p < .001$, 95% CI [-.03, -.01], confirming the hypothesis.

[Figure 5a about here.]

[Figure 5b about here.]

Consent Form

This project is being conducted by Etinosa Agbonlahor at the University of Warwick, UK with direct supervision from Professor Gordon Brown and Dr. Lukasz Walasek. The study is part of a final project for the MSc in Behavioural and Economic Science programme.

Your personal information will be kept confidential. All responses are anonymous, and a randomly generated ID number will be assigned to your responses. The only people who will have access to the data are experimenters involved in this project. You can withdraw from the experiment at any point if you wish to do so. Your participation in this research is completely voluntary. There are no risks associated with taking part in the study.

As a reminder, you are guaranteed $1.00 for your time. The experiment should not take longer than 10 minutes to complete.

--

1. I confirm I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions of a member of the research team and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.

3. I agree to take part in this study.

Please enter your Worker ID: _______

Introduction

Hello,
Thank you for participating in this study. The goal of this study is to better understand how people make decisions when faced with a range of options.

During the experiment you'll be asked to choose between two apartments based on their monthly rent and distance to the city center.

Please note there are no right or wrong answers.

The study will last approximately 5 minutes. You will earn a guaranteed $1 paid through your Mturk account.

A validation code will be presented to you at the end of the study, which you will need to enter into Mturk in order to be paid.

Finding an Apartment

Imagine you have just gotten a new job that will necessitate moving to a different city. Two of your friends have also gotten jobs in that city and you have all decided to share an apartment together.

Since you'll be starting your job before the others, you've offered to find a suitable place for you all to live.

You and your roommates will earn a combined sum of $6,000 each month which you will need to spend on rent and other necessities, so the apartment you pick cannot cost more than $6,000 in rent.

Part 1a

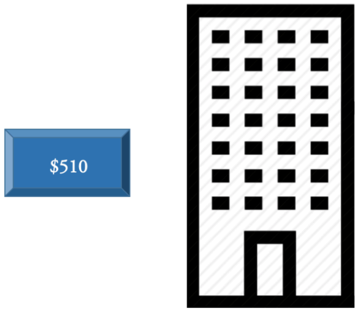
You've contacted a few real estate agents asking for quotes of rental prices for apartments around the city.

Each agent has sent you the rental values of specific apartments around the city.

Please pay attention to these values as you may be asked about them later on in the study.

On the next page, you will be given instructions on how to relay this information to your friends.

In order to relay this information to your friends, **please enter the value you see on the screen in the box below and then press 'next.'**



The apartment costs $

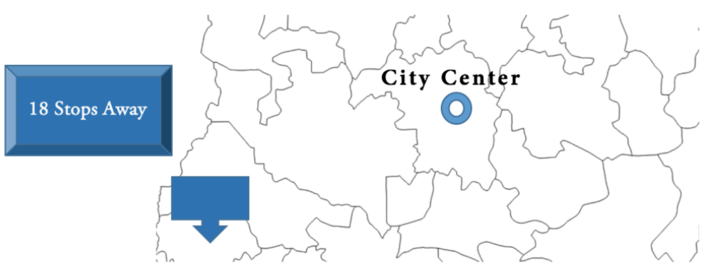
Part 1b

You've found a map that lists the number of bus stops between each apartment and the city center where you and your friends will be working.

Please pay attention to these values as you may be asked about them later on in the study.

On the next page, you will be given instructions about how to relay this information to your friends.

In order to relay this information to your friends, **please enter the value you see on the screen in the box below and then press 'next.'**



Number of bus stops from city center

Validation Test

Instructions

In this section, you'll be asked a few questions about the rental values and bus stops around the city.

Test Questions

You've now seen the rental values and bus stops of 16 apartments around the city. How many apartments are between 9 - 20 bus stops away from the city center?

How many apartments cost between $340 - $2,210 to rent each month?

How many apartments are between 0 - 11 bus stops away from the city center?

How many apartments cost between $1,870 - $3,740 to rent each month?

Sample Question (Q161) Presented to Indifference Group

In this part of the experiment you'll choose between apartments based on their monthly rent and how close they are to the city center where you and your friends will be working.

Remember, the apartment you pick cannot cost more than $6,000 in rent.

Please note there are no right or wrong answers. Any information collected will remain anonymous.

Which apartment do you prefer:

Apartment A

$510 rent

19 bus stops away from the city center

---------------- or -------------------------

Apartment B

$3,570 rent

1 bus stop away from the city center

- ◯ I strongly prefer apartment **A**
- ◯ I slightly prefer apartment **A**
- ◯ I strongly prefer apartment **B**
- ◯ I slightly prefer apartment **B**
- ◯ I'm indifferent between A and B; I would be equally happy with either.

Sample Question (Q161) Presented to Incommensurable Group

In this part of the experiment you'll choose between apartments based on their monthly rent and how close they are to the city center where you and your friends will be working.

Remember, the apartment you pick cannot cost more than $6,000 in rent.

Please note there are no right or wrong answers. Any information collected will remain anonymous.

Which apartment do you prefer:

Apartment A

$510 rent

19 bus stops away from the city center

---------------- or ------------------------

Apartment B

$3,570 rent

1 bus stop away from the city center

- ◯ I strongly prefer apartment **A**
- ◯ I slightly prefer apartment **A**
- ◯ I strongly prefer apartment **B**
- ◯ I slightly prefer apartment **B**
- ◯ I'm indifferent between A and B; I would be equally happy with either.
- ◯ I find it hard to choose between A or B. I can't say that I prefer them equally, but I also find it difficult to say which one I prefer.