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Relative Rank Predicts Judgements About Others' Pro-Environmental Behavior

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Relative Rank Predicts Judgements About Others' Pro-Environmental Behavior

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Abstract

Judgements about others' behavior is often made based on the relative rank of that behavior. We investigated this in the new domain of pro-environmental behavior, specifically for the categories of energy and water consumption, food (meat) consumption and transport choice. Using unimodal and bimodal distributions, we experimentally manipulated three fictional individuals' (common points) rank positions while keeping their absolute frequency of behaviors constant. Consistent with previous literature, participants' judgements about these people's pro-environmental behavior differed based on their rank position. Rank effects were not moderated by the perceived Importance of others' behavior, the perceived Visibility of the behavior, or the perceived level of Control. The results of this experiment are in line with a Decision by Sampling account of judgments of pro-environmental behavior, and set a foundation for future research seeking to conduct behavioral interventions (such as rank-based nudges) within this domain. Prior to this, however, future studies should investigate whether the smaller effect sizes found in this experiment, compared to those seen in previous research, are attributable to methodological differences, or the domain itself.

Keywords: Decision by Sampling; Rank-Based Judgement; Pro-Environmental Behavior; Energy and Water Consumption; Meat Consumption; Sustainable Transport.

Introduction

In order to combat climate change, and to reach maximum warming targets of 1.5 to 2 degrees Celsius, urgent action is needed to limit Greenhouse Gas (GHG) emissions (IPCC, 2023). As humans are the root cause of rising temperatures (IPCC, 2023), reducing individuals' emissions is important. Household consumption accounts for approximately 65% of GHG emissions, with food choices (meat consumption) and transport choice (driving / owning a car with a combustion engine) contributing to some of the highest emissions (Inanova et al., 2015; 2020). Dietz et al. (2009) suggest that, in addition to these behaviors, reducing standby electricity and household heating temperatures are some of the most effective ways of reducing household GHG emissions. They found that a combination of these behaviors results in a potential emissions reduction of 135.8 million metric tons of carbon (58% of the total emissions from behaviors included in their investigation)[1]. The importance of addressing household consumption is further exacerbated by the fact that low-income households are increasing their energy consumption at a higher rate than high-income houses are reducing theirs, and increasingly so (Sager, 2019). Therefore, finding suitable strategies for increasing individuals' pro-environmental behavior is of paramount importance.

In order to effectively employ behavior change interventions, it is important to know how people make judgements and decisions. Decision by Sampling (DbS; Stewart et al., 2006) posits that people evaluate quantities depending on how they rank within a comparison distribution. For example, when judging how high or low one's energy use is, one compares their usage with that of a sample of other people. Where their usage ranks in that distribution determines their judgment of how high or low their consumption is. This is in contrast to making a judgment based on the absolute amount of energy one uses; if two individuals within two different samples use the same amount of electricity, but one ranks higher in their sample, the judgement about their energy consumption will be higher.

To investigate the impact of rank position on judgments, absolute values can be held constant while rank positions are manipulated. One way in which this has been achieved is through a 'Distribution Manipulation' methodology. Either unimodal or bimodal distributions of judgement stimuli are created, such that common points within each of these distributions have the same absolute values but different rank positions. Using this Distribution Manipulation methodology, numerous studies have provided support for DbS across a variety of domains: the economic and financial domain, specifically tax allocation (Mellers, 1986), salary (Brown et al., 2008) and debt (Aldrovandi et al., 2015); the legal domain, specifically sentence severity (Aldrovandi, Wood & Brown, 2013); mental health, specifically symptom severity (Melrose, Brown & Wood, 2013); personality traits (Wood et al., 2012b); gratitude (Wood, Brown & Maltby, 2011); physical health, specifically alcohol consumption (Wood, Brown & Maltby, 2012a), exercise frequency (Maltby et al., 2012), tooth brushing duration (Maltby et al., 2016), and pain severity (Watkinson et al, 2013); and finally, student satisfaction in the higher education domain (Brown et al., 2015). As DbS has not yet been investigated in the domain of pro-environmental behavior, the primary aim of this study is to investigate this, using behaviors which

[1] Dietz et al. do not include meat consumption in their study due to the inaccuracies of carbon emissions calculations.

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.*

contribute significantly to household emissions (i.e. energy and water consumption, meat consumption, and transport choice). Firm evidence for the relevance of DbS to pro-environmental behavior would suggest the likely utility of a rank-based behavior change intervention.

Rank-based nudging (Aldrovandi, Brown & Wood, 2015) applies findings of DbS to a behavioral change intervention. Rather than communicating what the average behavior is (e.g. "You think that others eat 14 bars of chocolate each week. The actual average consumption is 7 chocolate bars per week"), RBN communicates the difference between where the participant thought they ranked, as opposed to where they actually rank (e.g. "You think that 20% of others eat less chocolate than you do, or only the same amount. In reality, 55% of others eat less chocolate than you do, or only the same amount"). RBN has already been shown to be effective in changing behavior in the domains of healthy eating (Aldrovandi et al., 2015), tooth brushing (Maltby et al., 2016), alcohol consumption (Dimeff, 1999; Neighbors, Larimer & Lewis, 2004; Neighbors et al., 2006; Lewis & Neighbors, 2007; Lewis et al., 2007; Taylor et al., 2015; Pariera et al., 2018), and improving communication about sexual health between parents and children (Pariera & Brody, 2021). Within the pro-environmental behavior domain, mean-based social norms (MBNs) have frequently been used to encourage more sustainable behavior (for reviews see: Cialdini, 2003; Nyborg, 2018), however they often provide small effect sizes (Nisa et al., 2019). RBNs might provide a tool to increase the efficacy of norm-based behavior change interventions.

Although DbS has a great deal of support (across a variety of domains, as listed above), not all studies have yielded successful outcomes. Maltby et al. (2016) found no significant difference between RBN and MBN in increasing tooth brushing duration. Pariera and Brody (2021) found that neither RBN or MBN were more effective in increasing sexual health communication between parents and children, in comparison to a control condition in which no normative information was communicated. Additionally, Pariera (2018), in a replication of Taylor et al. (2015), investigated RBN's effectiveness in reducing alcohol consumption and increasing information seeking behavior. However, where Taylor et al. found that RBNs increased information seeking behavior, with no effect on reducing alcohol consumption, Pariera et al. observed the opposite. One potential explanation for these findings is that rank misestimation (the difference between where the participant thought they ranked and where they actually ranked) was not investigated (or at least reported) in these studies. Without rank misestimation, one would not expect RBN to be effective, as without it the intervention effectively communicates information the participant already knows (e.g. "You think that 20% of others eat less chocolate than you do, or only the same amount. In reality, 20% of others eat less chocolate than you do, or only the same amount"). And if the original rank misestimation is in the opposite direction, potential backfire effects may occur, increasing the behavior one wishes to decrease (or vice versa). An additional possibility is that some domains or behaviors are not (or not as) influenced by rank as others. In the present paper, we therefore test whether judgments about pro-environmental behavior are primarily informed by relative rank considerations, as an initial indicator of the likely efficacy of RBNs in this domain.

DbS assumes that relative rank influences all judgments, and no evidence suggests that it is domain specific; all published research (to the best of our knowledge) finds strong evidence[2] that judgements are made based on the relative rank position. As highlighted above, however, we are aware of no studies that have explicitly investigated this in the domain of pro-environmental behavior. In a previous normative data collection and rank investigation study (Coulson & Harris, 2021), findings showed that rank position was not a significant predictor of how high individuals thought their meat consumption was. This raises two fundamental questions relating to DbS. Firstly, when using the pre-established Distribution Manipulation methodology, are judgements about others' behavior affected by their relative rank position within the domain of pro-environmental behavior? Secondly, and an explorative aspect of this research, can we identify specific psychological factors that increase or decrease rank effects within this domain?

We hypothesize that judgements of environmental behavior will be affected by the relative rank of that behavior. Specifically, we predict an interaction between judgment target and behavior distribution: Common Point 1 will be judged lower in the Unimodal than the Bimodal Distribution (where it has a rank position of 2 and 5 respectively – see Table 1). Common Point 3 will be judged higher in the Unimodal Distribution than the Bimodal Distribution (ranks of 10 and 7 respectively – see Table 1).

Methods

Participants

138 participants (77 female, 60 male, 1 other) aged 21–70 (median = 43 years) were recruited via Prolific. They were all fluent in English, residents of the UK and had an approval rating of 100%. 7 participants were excluded from analysis due to not finishing the study, failing at least one of the three attention check questions, or for having response ranges ≤ 1. An additional 7 participants were excluded as the Kendall coefficient was above .5 between responses and stimuli for the energy and water category and below -.5 between responses and stimuli for the food and transport categories. All exclusion criteria were pre-registered[3].

[2] The median partial eta squared of the experiments in the research previously discussed is .3.

[3] The pre-registration for the experiment can be accessed at: https://osf.io/h3tjb/?view_only=b581f8f7bf114c2fa4ee4a319257b828

Design and Materials

The dependent variable of interest was participants' ratings of the environmental friendliness of individuals' behavior patterns across three pro-environmental categories. The study implemented a 2x3x3 mixed design: Distribution (between subjects: Unimodal or Bimodal – see Table 1); Common Point (within subjects: Common Point 1, 2 and 3); Pro-environmental Category (within: energy & water consumption, food consumption, and transport choice).

For each Category of behavior, participants received information about 11 (fictional) people's pro-environmental behavior (see Figure 1). The distribution of behavior was manipulated between participants (see Table 1)[4]. As shown in Figure 1, the information about the full distribution of (a category of) behavior was presented in ascending order on screen whilst participants evaluated every individual (not just the 3 common points). The order in which participants viewed each Category, and the order in which the individuals were rated, were randomized. Participants rated how environmentally friendly the individuals were on a 1-7 scale, with endpoints labelled "Very Environmentally Unfriendly" and "Very Environmentally Friendly"[5].

Common Point 1 and 3 are critical common points, they have the same absolute value but a different rank position within each distribution. In the Unimodal Distribution Common Point 1 ranks lower than in the Bimodal Distribution. This is reversed for Common Point 3, whereby the rank position is higher in the Unimodal Distribution than the Bimodal Distribution. Common Point 2 by comparison, has the same absolute value and rank position in both distribution conditions.

Three exploratory questions investigated potential factors which may affect rank effects. Firstly, participants were asked to judge the extent to which they agreed with the statement that an individual's behavior should be judged relative to other people's behavior ('Rank Importance'), secondly they were asked to what degree they thought the behaviors were done in private ('Visibility') and finally, how much they thought the average person in the UK had control over the degree to which they did these behaviors ('Control'). These were measured on either a 1-5 Likert scale (Rank Importance: Strongly Disagree; Disagree; Neither Agree nor Disagree; Agree; Strongly Agree), or a 0-100 scale (Visibility and Control) with endpoints labelled either: 'Never done in private', to 'Always done in private', or 'No control whatsoever', to 'Absolute control'. These questions were presented separately and in a randomized order for each category. An additional explanatory statement was given to aid understanding prior to the 'control' question: "The ability to behave in a certain way is sometimes limited by factors outside a person's control. For example, a person on a low income may want to buy organic fruits and vegetables but be unable to because of the price. Similarly, local recycling facilities will constrain a person's ability to recycle. In contrast, the degree to which someone litters, is nearly entirely under their own control.".

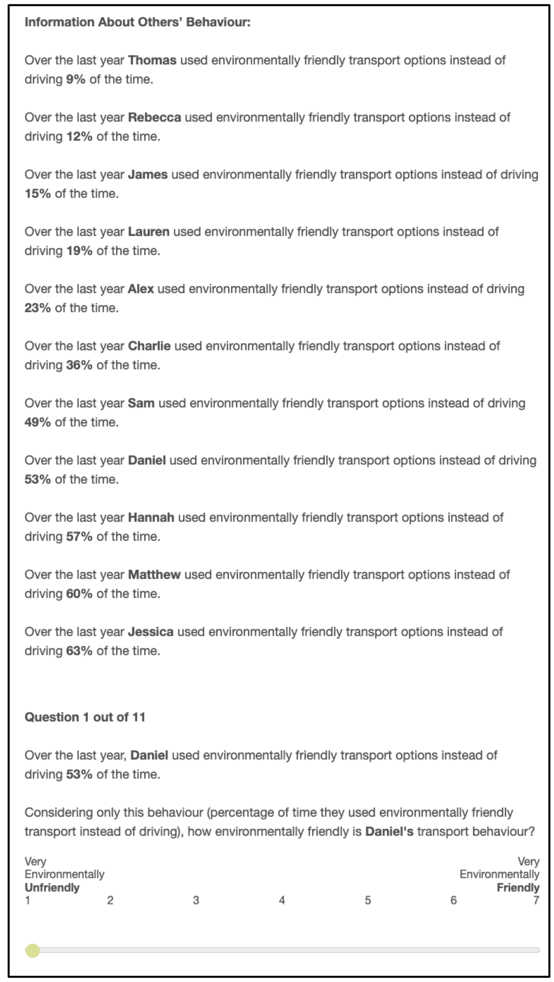

Figure 1: Example of the judgement question (screenshot taken of the experiment in Qualtrics).

Procedure

After being directed to the experiment from Prolific, participants first read the information sheet and completed the consent and demographic questions. They then received information about the climate impact of the category specific behaviors, and the distribution of others' behavior. After 15 seconds, participants were able to proceed to rate the named individuals' pro-environmental behavior. Attention checks 1 and 2 were given before and after this section[6]. After

[4] The food consumption and transport behavior categories directly replicate previous distributions (Melrose et al., 2013 and Wood et al., 2012b respectively).

[5] A 1-7 scale (rather than a 1-11 scale) was chosen to reduce experimental demand effects, whereby the 11 individuals were easily ranked.

[6] Attention Check 1: "Select the color 'Blue' for this question", with multiple choice options of: "Green, Red, Blue or Yellow"; Attention Check 2: "Select the shape 'Square' for this question", with multiple choice options of "Square, Triangle, Oval, Circle"; Attention Check 3: "In which year were you born?".

Table 1: Unimodal and bimodal distributions for others' behavior, separated by pro-environmental category (units provided in brackets). Highlighted names are common points (CP1, CP2 & CP3): Common Point 2 has the same absolute value and rank position, whereas Common Points 1 and 3 have the same absolute value but different rank positions.

Energy and Water Consumption (Minutes / Hours)																	
Unimodal	2				6	7	8	9	10	11	12	13	14				18
Bimodal	2	3	4	5	6				10				14	15	16	17	18
Food Consumption (Days)																	
Unimodal	3				10	12	13	14	16	18	19	20	22				29
Bimodal	3	4	6	8	10				16				22	24	26	28	29
Transport Behaviour (Percentage)																	
Unimodal	9				23	27	30	33	36	39	42	45	49				63
Bimodal	9	12	15	19	23				36				49	53	57	60	63

completion of all environmental categories, participants then stated their own behavior frequency for each category (although this information was outside the scope of investigation of this paper). Finally, for each category separately, participants answered the three exploratory questions. The third attention check was then given along with the debrief.

Results

Although data was normally distributed (Shapiro-Wilk $p<0.05$), visual inspection of QQ plots suggested that the residuals were not normally distributed. As ANOVAs are robust to violations of the normality assumption no corrections were performed. Homogeneity of variance was present, as assessed by Levene's Test. Outliers were present (as assessed by visual inspection of boxplots) but were included in the analysis as thorough exclusion criteria had already been conducted and no further exclusions were pre-registered. The assumption of sphericity was violated for the error terms of all main effects and interactions, therefore a Greenhouse-Geisser correction was used during all significance testing.

As the frequency of a behavior increased, judgements about the environmental friendliness of the behavior increased[7]. Crucially for the present investigation, judgements of Common Point 1 were higher in the Bimodal Distribution than the Unimodal Distribution, whilst judgements of Common Point 3 showed the opposite pattern (see Table 2 for a summary of these results).

A three-way ANOVA confirmed the robustness of these behavioral trends.[8] There was a main effect of Common Point: as pro-environmental behavior increased, judgements about others' behavior increased, $F(1.60, 195.03) = 763.83$, $p < .001$, $\eta_p^2 = .86$. Of central interest, there was a significant interaction between Common Point and Distribution, $F(1.60, 195.03) = 5.77$, $p = .007$, $\eta_p^2 = .05$. There was no three way interaction between Common Point, Distribution and Category, $F(3.41, 415.97) = 0.87$, $p = .470$, $\eta_p^2 < .01$[9] (for transparency, all descriptive results are shown in Figure 2).

Table 2: Mean judgements about others' pro-environmental behavior (standard deviation in brackets).

Common Points	Unimodal distribution	Bimodal distribution
CP 1	2.74 (1.15)	2.93 (1.02)
CP 2	3.81 (1.14)	3.87 (1.07)
CP 3	5.20 (1.06)	4.99 (1.06)

To investigate the exploratory research question, whether rank effects of pro-environmental judgements are moderated by the perceived Importance of others' behavior, perceived Visibility, and perceived level of Control, these covariates were entered as interaction terms to the ANOVA. As no three-way interaction was found, and the interaction between Common Point and Distribution was of primary interest, the factor of Category was removed from the ANCOVA model. The mean covariate values between categories were used and standardized (mean centered). The Common Point and Distribution interaction remained significant with the addition of the covariates ($F(1.64, 177.08) = 6.31$, $p = .004$, ηp2= .06). No interactions were observed involving any of the covariates (all ps > .06).

[7] Prior to analysis, Category 1 Common Points (1 and 3) were switched, as this category was reverse coded compared to categories 2 and 3. This was not included in the preregistration, but ensured consistency in the direction of the relationship between the independent and dependent variables across categories.

[8] ANOVA formula: Judgement ~ Category * Distribution * Common Point + (Common Point * Category | ID)

[9] An additional main effect of Category, $F(1.72, 209.51) = 43.82$, $p < .001$, $\eta_p^2 = .26$, and interaction between Category and Common Point, $F(3.41, 415.97) = 9.24$, $p < .001$, $\eta_p^2 = .07$, was also found. As no three-way interaction was present, results relating to Category are not of interest in relation to our hypothesis.

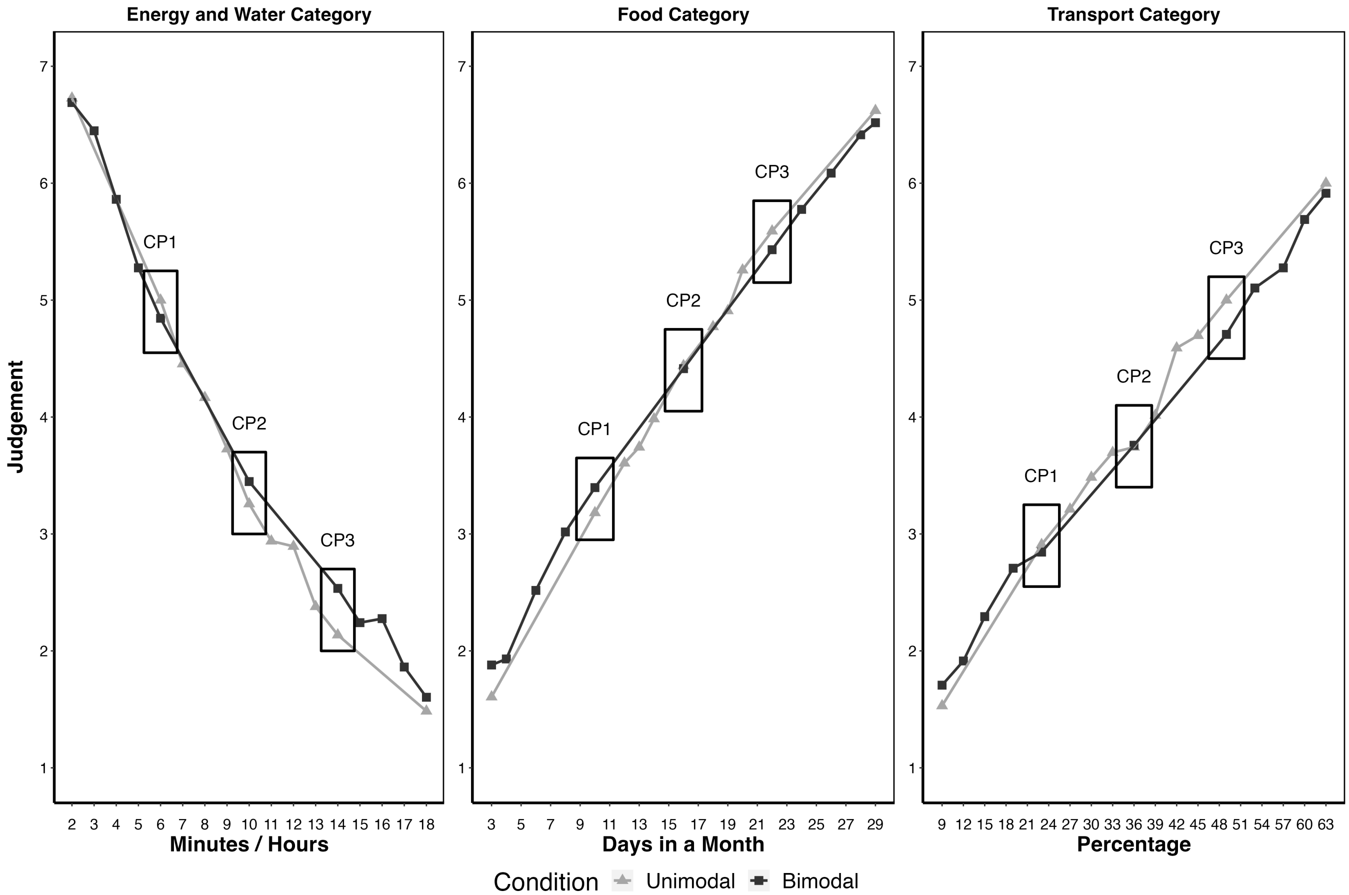

Figure 2: Judgements about others' pro-environmental behavior for each Distribution. Judgements represent how environmentally friendly participants thought others' behavior was. Common points are labelled and represent the same absolute value, but different rank positions dependent on whether the distribution is unimodal or bimodal.

Discussion

Our findings are consistent with DbS, in that judgements about others' pro-environmental behavior were found to be influenced by rank position, where the absolute level of the behavior was held constant. In line with previous research, Common Point 1 was judged lower in the Unimodal Distribution (where the rank was lower) compared to the Bimodal Distribution (where the rank was higher), and Common Point 3 was judged higher in the Unimodal Distribution (where the rank was higher) in comparison to the Bimodal Distribution (where the rank was lower). For all common points, the absolute frequency of behavior remained the same, therefore differences in judgement can only be attributed to the differences in rank position.

The lack of a three-way interaction with Category suggested that there was no reliable difference in the size of this effect across categories (as in Aldrovandi et al., 2013; Wood et al., 2012a; Wood et al., 2012b), although numerically the effect did not appear to be present in the Transport Category at Common Point 1 (see Figure 2). Additionally, the covariates of the perceived Importance of others' behavior, the perceived Visibility of the behavior and the perceived level of Control, did not moderate the rank effects. Together, these provide support for DbS, further suggesting the ubiquity of rank effects.

Interestingly, in comparison to previous unimodal and bimodal Distribution Manipulations, the Common Point and Distribution interaction effect size is relatively small (η_p^2= .05). Of the 16 previous published experiments (mentioned in the Introduction), the smallest effect size found was η_p^2=.08 (Watkinson et al., 2013), while the median effect size for all the experiments was η_p^2= .3. The most likely explanation arises from one main methodological difference, the randomized sequential judgments of the stimuli (individuals). To the best of our knowledge, in previous studies the distributional information, and subsequent judgment questions, were presented in order (either ascending or descending)[10], and were presented simultaneously. Only Watkinson et al. (2013) sequentially presented and

[10] We thank Gordon Brown for sharing this information about a number of past studies.

randomized the order of the dependent variables while manipulating the distribution modality, as was done in the current study. Their effect size (η_p^2= .08) is most similar to our own, however potentially increased due to the additional inclusion of both a practice block, and two identical critical blocks. It is logical to assume that when stimuli are presented simultaneously and in ascending or descending order (non-randomized), rank effects are heightened, as the order in which judgments are made is directly related to the variables' rank position. Qian & Brown, (2005) and Niedrich et al. (2001) provide tentative support for this, as, although they did not vary the distributions by modality, rank was weighted less within the RFT model[11] when judgment questions were presented randomly and sequentially compared to non-randomly and simultaneously (Qian & Brown, 2005) or randomly and simultaneously (Niedrich et al., 2001). As DbS (Stewart et al., 2006) states that samples are, in part, drawn from the external environment (decision context), and as these are likely to naturally occur in a randomized order, this experiment provides support for rank effects while using a more ecologically valid measure (albeit while finding lower effect sizes).

There are two further potential explanations for the smaller effect size observed in the current experiment. Firstly, this may indicate that the degree of rank effects are domain dependent. Evidence for this is lacking however, as the variance in effect sizes between domains in previous literature does not appear to be reliably larger than that within domains (e.g. within the financial domain, the partial eta squared varies between .21 and .84, and in the health domain, the partial eta squared varies between .08 and .84; effect sizes found within: Aldrovandi et al., 2015; Brown et al., 2008; Watkinson et al., 2013; Maltby et al., 2012, respectively).

A second explanation for the small effect size is the comparatively ambiguous relationship between the independent and dependent variables in the current experiment. All previous Distribution Manipulation experiments had an unambiguous relationship between the independent and dependent variables: e.g. units of alcohol consumed (independent variable) and the likelihood of alcohol related illness (dependent variable; Wood et al., 2012a). In comparison, within this experiment, rating the environmental friendliness is less directly related to the behaviors in question (e.g. minutes spent in the shower). For example, is the relationship between the environmental impact (and thus 'friendliness') of the behavior known to the participant? Or, to what degree is this specific behavior responsible for environmentally friendliness within this category? Two methodological attempts were made to mitigate this ambiguity. Firstly, within each category the environmental impact of each behavior was described before any distribution information or judgement questions were given. Secondly, the statement: "considering only these behaviors" followed by the category specific behaviors (e.g. "time spent showering, time lights were left on while out of the room, and time using heating in winter") was provided before each judgement question. Furthermore, the significant main effect of Common Point suggests that participants were aware of the relationship between the specific behavior and its environmental impact (e.g., Figure 2). However, it remains unclear whether rank effects were moderated by the degree of presumed environmental impact of the behaviors and / or the influence of other behaviors within the category (not specified in the experiment). Future studies should measure the strength of relationship between the independent and dependent variables.

Conclusion

Results from this experiment provide evidence of relative rank effects for judgments about others within the domain of pro-environmental behavior. This validates DbS within this domain and allows for future studies to investigate rank-based behavior change strategies (e.g. rank-based nudges). Initially, however, further research might fruitfully investigate whether the smaller effect sizes are a consequence of methodological differences (i.e. the sequential and random presentation of the stimuli), or the indirect relationship between the independent and dependent variables. In the unlikely event that smaller rank effects are found across the entire domain of pro-environmental behavior, researchers should be aware that rank-based nudges might not have the same positive effects on behavior as has been observed in other domains.

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