The utility of vagueness: does it lie elsewhere?

Matt Green (mjgreen@abdn.ac.uk)
School of Natural and Computing Sciences, Meston Walk
Aberdeen, UK

Kees van Deemter (k.vdeemter@abdn.ac.uk)
School of Natural and Computing Sciences, Meston Walk
Aberdeen, UK

Abstract

Much of everyday language is vague, yet standard game-theoretic models do not find any utility of vagueness in co-operative situations. We report a novel experiment, the fourth in a series that aims to discern the utility of vagueness from the utility of other factors that come together with vagueness. We argue that the results support a view of vagueness where the benefits that vague terms exert are due to other influences that vagueness brings with it rather than to influences of vagueness itself.

Keywords: Vagueness; experiment

Introduction

The classic Keefe and Smith (1996) gives what we shall call the standard definition of vagueness: “vague predicates have borderline cases, have fuzzy boundaries, and are susceptible to Sorites paradoxes” (p. 4). A canonical example is the concept *tall*. Lipman (2009) argues that a limitation of standard game-theoretical models of communication is that they are unable to explain why so much of everyday language is vague in what we called the standard sense. Among others, van Deemter (2009) argues that benefits of vagueness can accrue when, e.g., vagueness reduces costs for speaker or hearer.

One feature of previous work on the utility of vagueness is that the term *vagueness* is used in different ways by different researchers, e.g., Peters et al. (2009); Mishra, Mishra, and Shiv (2011). In each case empirical benefits are demonstrated of a factor that constitutes vagueness in a way that does not meet the standard definition. For example, the Mishra et al. (2011) work describes benefits of a factor described as vagueness that really amounts to adding (versus not adding) margins of plus and minus 3% to a value that is then presented to participants. Adding these margins does not seem to us to permit borderline cases: the margins instead define a range crisply. In Peters et al. (2009) vague terms (poor, fair, good, excellent) are added (versus not added) to a numerical value. While these words do permit borderline cases as in the standard definition, the vague words appear together with an added plot that indicates the borders of each term crisply on a numerical scale.

These examples show that manipulations that are intended to add vagueness to otherwise crisp numerical values sometimes do not succeed in a way that satisfies the standard definition of vagueness. In a series of experiments we set out to manipulate the borderline cases aspect of vagueness, by comparing crisp and vague references to objects based on cardinality. In doing so we have found that the vague form, while it may meet the standard definition, and while it may bring benefits, often contains other features apart from the borderline-cases aspect of vagueness. These other features bring with them their own influences (possibly benefits) that are not attributable to the presence of borderline cases in the vague term. The empirical challenge is then to factorially isolate the influence of borderline cases from these other influences that seem to come with vagueness, across a series of experiments.

Previous experiments in the series

The experiment reported in this paper is the fourth in a series - the previous three experiments are described in detail in Green and van Deemter (2011) and summarised in this section.

A pilot experiment was carried out first. Each stimulus consisted of a pair of squares containing the following number of dots: (2,4) (2,6) (3,5) (5,9) (6,8) (7,3) (7,9) (8,4), and an instruction to choose one of the squares with reference to the number of squares - this was either crisp (e.g., *Choose the square with seven dots*) or vague (e.g., *Choose the square with many dots*). The task was to select the appropriate square by means of a key press. Responses were timed and error rates were recorded. The main focus was to compare responses to vague instructions with responses to crisp instructions, hypothesising that in line with the cost reduction hypothesis (Green & van Deemter, 2011), vague instructions would yield faster and more accurate responses. We found that vagueness did not exert a main effect. Instead, vagueness had different effects depending on whether one of the squares contained a subitizable[1] number of dots. For stimuli that did contain a subitizable number of dots, vagueness tended to produce longer response times and more errors, against the cost reduction hypothesis. For stimuli that did *not* contain a subitizable number of dots, vague instructions yielded faster response times and fewer errors, but only when the instruction identified the larger number in the pair.

In a follow up experiment we used only non-subitizable numbers of dots in the squares, as follows: (5,25) (10,25) (15,25) (20,25) (30,25) (35,25) (40,25) (45,25). The instructions were either crisp (e.g., *Choose the square with 45 dots*) or vague (e.g., *Choose the square with many dots*). This time we found that vague instructions reliably yielded faster and

[1] *subitizable* is used to refer to quantities smaller than 4

more accurate responses, but that the vagueness advantage diminished as the size of the difference in the number of dots grew larger, as plotted in Figure 1.

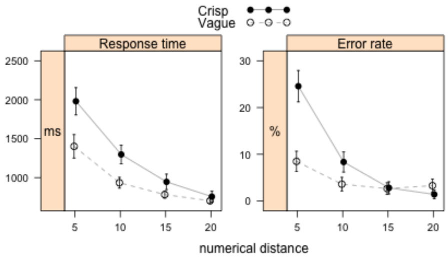

Figure 1: Experiment 2 results

We could not be sure from this experiment whether the vagueness advantage was really due to vagueness or to number-avoidance because one feature of this way of operationalising vagueness is that all the vague instructions avoided numbers while all the crisp conditions mentioned numbers: thus the vagueness advantage may have been an advantage for avoiding numbers in the instructions.

Another feature of this way of operationalising vagueness is that the nature of the forced choice task varies over the vague and crisp forms. The vague terms invite the participant to *compare* the target identified in the instruction against the distractor to establish that one square is more or less numerous than the other. The crisp forms invite the participant to *match* the target identified in the instruction with one of the two squares in the stimulus – this means that the participant must establish the numerosity of the squares more accurately, which is presumably time-consuming and could therefore explain the vagueness advantage that we observed as a benefit for the less time-consuming *comparison* task.

At this stage we had identified a response time advantage for vague instructions versus crisp instructions, and we had identified some plausible alternative explanations for the effect: number-avoidance in the vague conditions versus number-use in the crisp instructions; and comparison in the vague instructions versus matching in the crisp instructions.

We set out to plan a series of experiments that could distinguish vagueness from these other factors. Firstly, we wanted to make sure that we were dealing with vagueness in the classic sense that focuses on the presence of borderline cases. Both the pilot experiment and the follow-up used 2 squares in each stimulus and a definite article in the instruction. We increased the number of squares to three, and changed the definite article to an indefinite article in the vague forms so that any vague reference to *a square with few dots* or *a square with many dots* would have more than one candidate target square such that one of the candidate squares would represent a borderline case of the vague expression - this ensured that the potential for vagueness in terms like *many* and *few* could be realised in the experiment.

Our approach to distinguishing the effects of vagueness from those of number-avoidance and comparison was to take each of the alternatives separately and set up a factorial experiment that crossed the influence of the alternative with vagueness under the expectation that the alternative explanation would be given a chance to exert itself as a main effect, and that if vagueness had any additional explanatory value it would interact with the main effect of the alternative explanation.

This led us first to plan an experiment that pitted vagueness against number-use, to test the hypothesis that number-avoidance could explain the vagueness advantage. In this third experiment in the series, sets of numbers were as follows: (6,15,24) (16,25,34) (26,35,44) (36,45,54). We also manipulated number use and vagueness factorially in the instructions. This gave four conditions for the instructions, in which we used an indefinite article to reflect that there can be more than one appropriate response when there are borderline cases: crisp number, *Choose the square with 16 dots*; crisp word, *Choose the square with the fewest dots*; vague number, *Choose a square with about 20 dots*; vague word, *Choose a square with few dots*. We found a main effect of number use, but no interaction with vagueness and no main effect of vagueness. The number-avoiding instructions yielded faster responses than the number-using instructions, but within the number-using instructions there was no effect of vagueness, and within the number-avoiding instructions there was no effect of vagueness, as plotted in Figure 2. The third experiment showed us that we could not reject number-avoidance as an alternative explanation of the vagueness advantage, although we could not distinguish between benefits of number-avoidance and benefits of the the comparison task in this experiment.

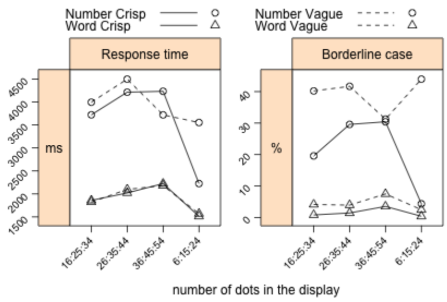

Figure 2: Experiment 3 results

Next we set up two experiments to pit vagueness against the second alternative explanation (an advantage for the *comparison* task versus the *matching* task). We decided to plan two experiments to cover this because we wanted to take into account the possibility that number-avoidance could be the driver for the benefits that we had identified in experiment 3 and control for this by keeping it constant within each experiment while we manipulated vagueness and the selection task. We set up two factorial manipulations of vagueness with selection task, one at each level of number-use, to form experiments 4 (discussed in this paper) and experiment 5 (in preparation to be run at the time of writing). The present Experiment 4 constitutes a factorial manipulation of vagueness and selection task with the constraint that all conditions must use a number in the instruction. If we found an effect of vagueness on the main effect of selection task in this experiment, we could then be sure that it was not explainable as an effect of number-use. Experiment 5 will constitute a factorial manipulation of vagueness and selection task with the constraint that all instructions must refrain from mentioning a number so that we can sure that any effect of vagueness on the main effect of selection task will not be explainable as an effect of number-use.

The current experiment

In this, the fourth experiment in the series, we manipulate vagueness in references to cardinality in which all references must use a number.

The domain consists of sets of three dot arrays, together with an instruction to the participant to choose one of these arrays, where the target is indicated in all conditions by its cardinality (see Figure 3 for an example stimulus, and Table 1 for examples of the instructions).

With reference to Figure 3, whereas to obey the instruction that says *'Choose a square with 6 dots'* requires the participant to establish that a square has the particular number of dots stated in the instruction (a *matching* task), the alternative *'Choose a square with fewer than 10 dots'* only requires the participant to distinguish the available squares from each other well enough to see that one contains the smallest number of dots (a *comparison* task). At each level of the selection task we also presented vague and crisp forms in a factorial 2x2 manipulation, and held number-use constant over all forms.

If vagueness is responsible for driving the advantages that we have seen so far, then it should exert a main effect in these exclusively number-using references to cardinality. On the other hand if the selection process factor is driving the advantages independently of the borderline cases aspect of vagueness then we should not observe any additional benefits in the vague references.

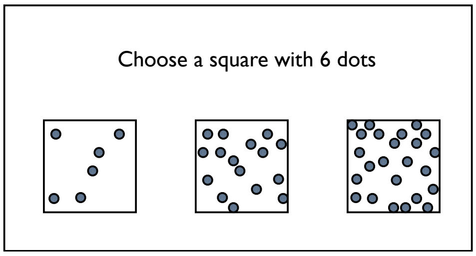

Figure 3: Experiment 4 example trial stimulus

Method

Apparatus

A MacBook Pro laptop with a 13 inch screen was used to display the stimuli and collect responses. The stimuli were presented and responses were collected using GNU Octave (Eaton, 2002) and the *Psychtoolbox* extensions for MatLab or Octave (Brainard, 1997). Statistical analyses were carried out using R (R Core Team, 2013). The statistical models were built using the *lmer* package and *p* values were obtained using the *lmerTest* package.

Design

In this experiment we factorially manipulated vagueness (with two levels, vague and crisp) and selection process (with two levels, matching and comparison), constraining all conditions to use numerals. This led to four experimental conditions illustrated in Table 1. There were several arrangements of numbers of dots, with each unique combination forming an experimental item. There were 4 such items containing sets of numbers of dots as follow: (6,15,24); (16,25,34); (26,35,44); (36,45,54). The position of the dots within a square was randomised for each square. Each trial appeared equally often with the smaller number on the left as with the smaller number on the right.

Participants

38 people volunteered to participate in a pair of experiments that included this one and an unrelated experiment in return for £7.50. These were students and staff at University of Aberdeen. 21 were male and 17 were female.

Procedure

On arrival, participants were seated in a quiet cubicle. The experimenter explained the task, indicating that participants should respond as quickly as possible while avoiding errors. There was a practice block of 6 trials during which the experimenter was present. After the participants had completed the practice block they were invited to ask any questions they might have. After answering these questions, the experimenter left the room for the main experimental block. The main experimental block took about 15 – 25 minutes. The participants then took a break. A second, unrelated, experiment was administered following the break. Participants knew that there were 2 experiments when they agreed to participate.

Hypotheses

We predicted a main effect of selection task and a main effect of vagueness, as follows:

1. We hypothesised that, in line with earlier experiments, the comparison task instructions would receive faster response times than the matching task instructions yielding a main effect of selection task.

Table 1: Examples of the wording of the instructions, by condition

Text	vagueness	selection process
Choose a square with 6 dots.	crisp	matching
Choose a square with about 10 dots.	vague	matching
Choose a square with fewer than 20 dots.	crisp	comparison
Choose a square with far fewer than 20 dots.	vague	comparison

2. We hypothesised that vagueness would exert a main effect such that vague comparison instructions would receive faster response times than crisp comparison task instructions (planned contrast 1), and vague matching task instructions would receive faster response times than crisp matching task instructions (planned contrast 2).

Results

A linear mixed effects model was built for Response Time (RT). The model included terms for Selection, Vagueness, and the Selection x Vagueness interaction, considered as fixed effects, as well as random slopes for the fixed effects at each level of participant and item. In the model of RT, the response time was log-transformed and was treated as gaussian-distributed. Table (2) shows the coefficients for the model of RT. The means for RT are given in Figure (4).

With reference to hypothesis 1, on average there was the predicted main effect of Selection on RT, with *comparison* conditions causing faster responses versus the *matching* conditions.

With reference to hypothesis 2, on average there was no reliable main effect of vagueness on RT. The planned contrasts that follow from hypothesis 2 were as follows: there was an advantage for vagueness in the planned contrast 'vague comparison versus crisp comparison'; there was an unreliable advantage for crispness in the planned contrast 'vague matching versus crisp matching'.

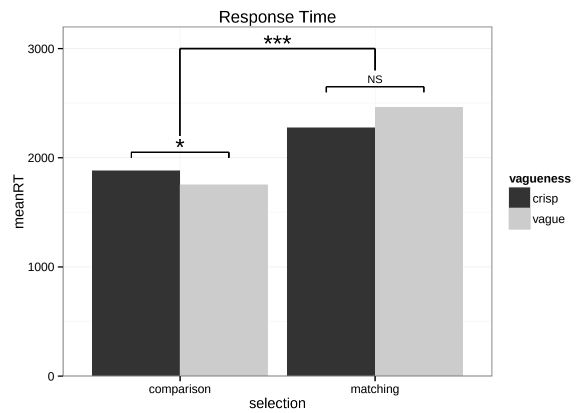

Figure 4: Mean response times by condition

Discussion

The main aim of this experiment was to test whether vagueness confers any cognitive benefits over and above those due to differences in the selection task according to whether the instruction mandates a *comparison* selection task or a *matching* selection task, when number-use is held constant.

The main effect of selection task showed that the assumption that the *comparison* task is easier than the *matching* task is well-founded. People were reliably faster at responding in the *comparison* task.

Vagueness did not exert a main effect in RT. However when the comparison and selection tasks were analysed separately, there was a small reliable decrease in RT from the crisp to the vague *comparison* tasks, but RT was not reliably affected by vagueness in the *matching* tasks.

The benefits of vagueness in the *comparison* task here could be explained as differences in the number of valid targets for the expression, as follows. Taking as an example the stimulus with (6,15,24) dots, it could be argued that the vague comparison instruction (e.g., *a square with far fewer than 20 dots*) has one valid target, the square with 6 dots, while the crisp comparison instruction (e.g., *a square with fewer than 20 dots*) has two valid targets, the squares with 6 and 15 dots. We found that people were quicker to identify a square when the instruction only had one valid target. This leads us to speculate that the benefit for vagueness here could be due to the vague expression foregrounding a particular valid target while the crisp expression carries with it the additional task of distinguishing between two alternative valid targets. We intend to follow up this possible benefit of vagueness, that could perhaps be called a "range-reduction" benefit, in subsequent experiments.

Taking stock now, what is the best explanation of our findings so far across the series of experiments?

Experiment 2 showed us that there are clear differences in RT according to whether the instruction is vague or crisp, but the experiment could not distinguish effects of vagueness from those of number-avoidance.

Experiment 3 showed us that number-avoidance is an important factor driving response times in the task, and that vagueness does not have any additional explanatory power at either level of number-use, but the experiment could not distinguish benefits of number-avoidance from those of the comparison selection task.

The present Experiment 4 showed us that there are ef-

Table 2: Coefficients and significance for a model of log transformed response times

	Estimate	SE	t	p	sig
Main effect of selection	0.19	0.05	4.13	0.00	***
Main effect of vagueness	0.00	0.05	0.10	0.93	
Interaction selection x vagueness	0.08	0.06	1.29	0.28	
Crisp comparison vs vague comparison	0.04	0.01	2.63	0.03	*
Crisp matching vs vague matching	-0.04	0.05	-0.78	0.49	

fects of the selection task mandated by the instruction when number-avoidance is controlled by making all the instructions use a number, and that within this vagueness exerts benefits when the selection task is *comparison*, but not when the task is *matching*. Our next experiment will test for effects of vagueness and selection task when number-avoidance is controlled by making all the instructions *avoid* using a number.

The findings from the experiments to date show that when vague expressions are compared with crisp alternatives in our forced choice task, vague expressions appear to yield benefits in some situations, but that the observed benefits may be due to factors other than vagueness itself that the vague forms bring along with them: factors like avoiding numbers and permitting comparison tasks. A possibility raised by the present experiment is that vague references might aid the identification of particular targets by reducing the range of valid targets in expressions like *far fewer than*.

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