TESTING THE ABSTRACTEDNESS ACCOUNT OF BASE-RATE NEGLECT, AND THE REPRESENTATIVENESS HEURISTIC,USING PSYCHOLOGICAL DISTANCE

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A Thesis

Submitted to the Graduate College of Bowling Green
State University in partial fulfillment of
the requirements for the degree of

MASTER OF ARTS

August 2017

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ABSTRACT

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Decision-makers neglect prior probabilities, or base-rates, when faced with problems of Bayesian inference (e.g. Bar-Hillel, 1980; Kahneman & Tversky, 1972, 1973; Nisbett and Borgida 1975). Judgments are instead made via the representativeness heuristic, in which a probability judgment is made by how representative its most salient features are (Kahneman & Tversky, 1972). Research has shown that base-rate neglect can be lessened by making individual subsets amenable to overall superset extraction (e.g. Gigerenzer & Hoffrage, 1995; Evans et al. 2000; Evans et al. 2002; Tversky & Kahneman, 1983). In addition to nested sets, psychological distance should change the weight afforded to base-rate information. Construal Level Theory (Trope & Liberman, 2010) proposes that psychological distances—a removal from the subjective and egocentric self—result in differential information use. When we are proximal to an event we focus on its concrete aspects, and distance from an event increases our focus on its abstract aspects. Indeed, previous research has shown that being psychologically distant from an event increases the use of abstract and aggregate information (Burgoon, Henderson, & Wakslak, 2013; Ledgerwood, Wakslak, & Wang, 2010), although these results have been contradicted (Braga, Ferreira, & Sherman, 2015). Over two experiments I test the idea that psychological distance increases base-rate use. In Experiment 1 I attempt to partially replicate previous research that indicates temporal psychological distance increases the use of the representativeness heuristic (Braga et al., 2015); that is, actually increases base-rate neglect. In Experiment 2 I tested this effect in problems of Bayesian inference, using the standard mammography (Eddy, 1982) and lawyers and engineers (Kahneman & Tversky, 1973) problems. My results provide preliminary,

converging evidence that both social and temporal psychological distances increase the use of base-rate information.

ACKNOWLEDGMENTS

There are many at Bowling Green I'm appreciative of. First, I'm thankful to my advisor, Dr. Richard Anderson, for all of his feedback and long hours spent revising and designing the project. Second, my committee members for their constructive criticisms. Lastly, I'm thankful to the members of Cognition Forum and everyone else who has listened to me talk about this project and given me thought-provoking questions to think about.

I'd also like to thank Dr. Dan Woltz at the University of Utah and Joao Braga at the University of Lisbon.

And of course, to my family for providing me with the opportunities that made me who I am today, and Tyler for pushing me to go further.

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CHAPTER 1: INTRODUCTION

Why do decision-makers fail to utilize important and relevant information when making a judgment? Bayes' theorem (Bayes, 1763) provides a normative standard for rationally updating the probability of a hypothesis when provided with new evidence. Gigerenzer and Hoffrage (1995) give Bayes' equation as:

$$P(H/D) = \frac{P(D|H) \times P(H)}{P(H) \times P(D|H) + P(-H) \times P(D|-H)} \quad (1)$$

Reading from left to right, this equation tells us that the posterior probability—the probability of a hypothesis H given data D—equals the hit rate times the prior probability divided by the probability of a positive result given that the hypothesis is true and a positive result given that the hypothesis is not true. However, neglect of prior probabilities, or base-rates, makes Bayes a questionable descriptive model of thinking.

According to research by Nisbett and Borgida (1975), decision-makers neglect prior probabilities because they find them remote and abstract. Instead of using base-rates, decisions are made via representativeness, the degree to which an event is representative of the population from which it originated (Kahneman & Tversky, 1972, 1973). Bar-Hillel (1980) further clarified this position, namely that base-rates are neglected because their abstractness makes them appear irrelevant to a decision-maker. However, Braga, Ferreira, and Sherman (2015) argued that base-rates do not exist on an abstract-concrete continuum at all. Rather, it is the existing contrasting information that is either abstract or concrete. For instance, a hit or false alarm rate may be concrete in one context or abstract in another. But, in general, Braga and colleagues argue that base-rates are simply the alternative information to other elements within Bayesian inference problems.

These principles, then, are not yet established beyond question, and have interesting implications that call for further study. The present research aims to further investigate how base-rates are conceptualized, why they are neglected, and attempt to increase base-rate use.

Removing oneself in space or time results in differential information use: With greater distance we make decisions with information that is abstract as opposed to the concrete decisions we make with closer distances (Trope & Liberman, 2010). Events and objects that we experience are made up of both an overall gist as well as constituent pieces. Thinking of an apple when we are psychologically distant from it, we will focus more on the central aspects or gist: the idea that it provides nourishment. When the apple is psychologically near, however, we are more focused on the constituent pieces: whether it is red or green and bitter or sweet. (Liberman and Trope, 1998). Bayesian inference problems are likewise made up of two pieces of information—a hit rate and a base-rate (as well as, in some cases, a false alarm rate). If base rate neglect is due to focus being placed on the hit rate—and base rates are neglected because they are abstract—it's possible that with psychological distance comes an increased focus on base rate information.

The Representativeness Heuristic

Although there are many dual-process theories (Epstein, 1994; Evans, 1989; Kahneman & Frederick, 2002; Sloman, 1996), they all posit two systems for thinking: one that automatically, or heuristically, processes information (sometimes called Type 1) and another that analytically processes information (Type 2). According to Evans (1989) and Kahneman and Frederick (2002), intuitive Type 1 judgments are expressed overtly only if endorsed by Type 2 processes. However, Type 2 endorsements are easily granted under normal circumstances. Consider a scenario in which a bat and a ball cost $1.10 in total, with the bat costing $1 more than the ball. Most people will state, incorrectly, that the ball must cost 10 cents (rather than 5

cents) because they trust the first plausible judgment that comes to mind. While Type 1 processes operate automatically, suppressing erroneous responses via Type 2 processes is effortful, and its efficacy is reduced by both memory load (De Neys, 2006) and time pressure (Evans & Curtis-Holmes, 2005).

One way to characterize heuristics is that they involve substituting the answer to a difficult question with the answer to an easier question, as in the *bat and ball* problem. In the dual-process heuristic-analytic theory (Evans, 1989), heuristics are a Type 1 process (Kahneman & Frederick, 2002). The first heuristic identified was representativeness (Kahneman & Tversky, 1972), in which a probability judgment is determined by how representative its most salient features are. Participants judged the likelihood a hypothetical person was an engineer (or lawyer) given a personality sketch and occupation rate. When the personality sketches were stereotypically descriptive of an occupation (e.g. "mechanical," "high intelligence," and "does not enjoy interacting with others" to describe an engineer), participants used this individuating information to make their judgment and largely ignored occupation rates, whether the sample consisted of 30% or 70% engineers. When a decision-maker focuses solely on hit rate information, Bayes' theorem is erroneously simplified to $P(H|D) = P(D|H)$. The posterior probability simply equals the hit rate.

A separate but similar type of base-rate problem involves false positives. In the *taxicab problem* (Tversky & Kahneman, 1982) and the *mammogram problem* (Eddy, 1982), we are told a priori that a certain amount of error has been introduced, either by limitations in the recall of the witness or the diagnosticity of a test, respectively. In Bayes' theorem (Gigerenzer & Hoffrage, 1995), the denominator is stated accordingly:

$$P(D|H) \times P(H) + P(D|-H) \times P(-H) \quad (2)$$

$P(D|H)$ is the chance of a true positive test and $P(D|-H)$ is the chance of a false positive test, while $P(H)$ is the probability of having breast cancer and $P(-H)$ is the probability of not having breast cancer. Incorporating false positive information is obviously normative, yet people routinely neglect to incorporate more than the hit rate when making decisions (e.g. Eddy, 1982).

Representativeness results in a bias wherein the diagnostic information is weighted at the expense of base-rate information. It is assumed that Type 2 processing is required for decision-makers to overcome this heuristic response. As would therefore be expected, Evans et al. (2002, Experiment 5) showed the influence of base-rates was stronger than diagnostic information if participants were required to rate the prior probability immediately prior to solving the problem, thus forcing explicit consideration of the base-rate.

However, participants in Fischhoff and Bar-Hillel's 1984 study underutilized base-rate information whether it was reiterated prior to solving the problem (i.e. "I believe he is one of the 30 business executives (or) one of the 70 university professors) or not (i.e. "I believe he is a business executive (or) a university professor).

If subjects do not use the representativeness heuristic when making such decisions, is the resulting reasoning predicated on Bayes' theorem? Bayesian reasoning requires weighting the hit rates and base-rates equally. Evans (Evans et al., 2002, Experiment 1) utilized a multiple linear regression to analyze the regression weights of hit rates and base-rates for each individual participant. The mean regression weights of the hit rates were 0.88, whereas the weight of the base rate were only 0.03. Base-rates were utilized, albeit minimally.

Novemsky and Kronzon (1999) found further converging evidence that humans are not natural Bayesians. They created questions modeled after the *lawyers and engineers* problem

(Kahneman & Tversky, 1973) with base-rates (10, 50 or 100) varied within-subjects and displayed to participants immediately following individuating information. The results were compared to a model of Bayesian reasoning and an additive model. The Bayesian reasoning model plotted posterior probabilities as a function of base-rates. The additive model was a linear model that linearly combined (e.g. summed or averaged) two terms (e.g. base-rate and individuating information). That is, there was no multiplicative interaction as would be required if they were using Bayes' theorem. The additive model was thus a linear regression model wherein the mean judged probability was plotted as a function of the weighted sum of the base-rate and the diagnosticity. The slope of actual participant responses fit best into the slope of the additive model. While participants weighted both the diagnostic information and base-rates, they summed, not multiplied, the two pieces of information.

One such problem structure that is more amenable to an additive operation partitions the information into subsets. In the standard *mammography problem* (Eddy, 1982), the base-rate (probability of breast cancer), hit rate (probability of a correctly diagnosed mammogram) and false-alarm rate (probability of an incorrectly diagnosed mammogram) are given in terms of single-event probabilities—such as 1%—that relate to a single, hypothetical woman. When, however, a decision-maker can easily visualize the partitioned categories—for instance if 10 out of 1000 women have breast cancer (base-rate) and 8 of the 10 with cancer (hit rate) and 95 out of 990 without cancer (false-alarm rate) will receive a positive mammogram—he is more likely to reach a Bayesian-consistent decision (Gigerenzer & Hoffrage, 1995). When the problem is presented in this type of frequency format, Bayes' theorem is simplified to:

$$\frac{d\ \&\ h}{d\ \&\ h + d\ \&\ -h} = \frac{8}{8+95} \tag{3}$$

The posterior probability now equals the number of cases with the symptom and the disease divided by the sum of the number of cases with the symptom and the disease and the cases having the symptom but not the disease.

If, however, they were given as single-event probabilities, the resulting equation would be:

$$\frac{(.01)(.80)}{(.01)(.80)+(.99)(.096)} \tag{4}$$

The idea that exhaustive subsets improve Bayesian reasoning is known as the nested-sets hypothesis (Tversky & Kahneman, 1983). Specifically, the nested-sets hypothesis states that presenting information in a manner that allows for the extraction of individual subsets relative to supersets facilitates reasoning (Sloman et al., 2003). The format of Equation 3, for instance, provides effective cues to the problem's underlying set structure.

Nested sets lead to improved reasoning regardless of whether problems are presented in frequency or probability formats (see Table 1). For instance, Evans (Evans et al., 2002, Experiment 2) presented varying base-rate formats between participants. One group saw frequencies, i.e. "400 out of 1,000," whereas the other group saw probabilities presented as a percentage, i.e. "40%." Participants in both situations were informed that two of four campus societies each contained 40% of the students, while the other two each had 10%. After being told the membership of one society, participants were asked to indicate their subjective probability that a person of that society was also in another society. The overall superset was therefore amenable to extracting individual subsets. The results indicated no significant differences in reasoning between frequency or probability formats.

Figure 1. Illustration of Nested and Non-Nested Stimulus Presentation Formats

	Nested	Non-Nested
Frequency Format	A test can detect the presence of a genetic marker, whose prevalence in the population is 200 out of every 1,000 people, with 100% accuracy.	A test can detect the presence of a genetic marker, whose prevalence in the population is 200 out of every 1,000 people, with 100% accuracy.
	However, of the 800 people who do not carry the marker, 80 will produce a positive test result.	However, of every 100 people who do not carry the marker, 10 will produce a positive test result.
Probability Format	A test can detect the presence of a genetic marker, whose prevalence in the population is 20%, with 100% accuracy.	A test can detect the presence of a genetic marker, whose prevalence in the population is 20%, with 100% accuracy.
	However, of the 80% of people who do not carry the marker, 10% will produce a positive test result.	However, 10% of people who do not carry the marker will produce a positive test result.

Note. Adapted from Evans et al. (2000). The superset is amenable to extraction when the subset of the false alarm rate is nested, regardless of whether the information is presented as a frequency or a probability.

However, in a review of the literature, Barbey and Sloman (2007) reported that while participants were more likely to reach the normatively correct decision using nested sets, even then participants rarely made Bayesian-consistent decisions. In fact, when using the simplified theorem, the base-rates of the disease are not explicitly represented but are implicit in the difference between the number of people who have the disease and the number who do not have the disease. Consequently, the decision maker does not need to explicitly consider base rates (Gigerenzer and Hoffrage, 1995). Thus, the apparent improvement in base-rate usage may not reflect base-rate usage, per se.

Construal Level Theory

Construal Level Theory proposes that we mentally construe of objects at different levels of abstraction given our psychological distance to the object (Trope & Liberman, 2010). In their review, Burgoon, Henderson and Markman define *abstraction* as "a process of identifying a set of invariant central characteristics of a thing" (2013, p. 502). That is, the cognitive process of abstraction reduces peripheral information while retaining central and unchanging features. So, when an *apple* is abstracted into a *fruit* the peripheral information of *redness* (or *greenness)* and *sweetness* (or *bitterness)* is disregarded and the idea that it is *edible* is retained.

We mentally traverse levels of construal through psychological distances. Psychological distances can be temporal, spatial, social, or hypothetical (Trope & Liberman, 2010). The common thread of a psychological distance is that it removes us from our subjective experience. As we become more psychologically distant from an object, we construe of it more abstractly. Likewise, as we become less psychologically distant from an object, we construe of it more concretely. Thus our construal, or mental representation of an event, changes given how psychologically distant we are from the event. Trope and Liberman (2010) posit that an abstract

concept of a given object or event is formed so that operations can be performed on it whether it is close to us or far away.

Bar-Anan, Liberman, Trope, and Algom (2007) tested the idea that these distances are automatically accessed and experienced in similar ways. Subjects were given a modified Stroop task consisting of an arrow pointing to either the foreground or background of a picture paired with a term of psychological distance or psychological proximity. (In the original Stroop task (Stroop, 1935), participants were required to name the color in which a word is printed while ignoring the color named by the word; for instance, participants viewed the word *red* printed in the color *blue* and were asked to respond "blue.") Experiments 6 and 12 used the words "maybe" and "sure" to test hypotheticality, words that denote distance and proximity, respectively. Participants were asked to respond to the location of the arrow, using the *D* key to indicate a proximal spatial location and the *J* key to indicate a distant spatial location.

Given that the psychological distance component was irrelevant to the Stroop task, shorter response times would suggest that different forms of psychological distance share a similar semantic meaning that is accessed automatically. Response times were faster for distance-congruent stimuli than for distance-incongruent stimuli, indicating distance-incongruent stimuli required more analytical processing.

Bar-Anan, Liberman, and Trope (2006) also used the Implicit Association Test (Greenwald, McGhee, & Schwartz, 1998) to show that an association exists between psychological distance and level of construal. Participants viewed pairings of distance and construal level that were congruent—low construal levels with psychological proximity or high construal levels with psychological distance—or incongruent. Participants were then asked to

categorize the stimuli using a left or right response key. Response times were quicker in congruent pairings.

If psychological distances all share a similar, automatically accessed meaning, then a temporal psychological distance should have similar psychological effects of a social psychological distance. Pronin, Olivola, and Kennedy (2008) tested the idea. In one condition, participants made what they believed were real decisions about how much of a disgusting liquid they would drink in the present (i.e. during the experimental session) or in the future (next semester). A second group was told they were making these decisions for the next participant in the study. In the third condition, participants were asked to imagine a hypothetical situation in which they would make the decision either for themselves or another person. In the hypothetical situation there were no significant differences in the amount of liquid chosen, whether it was for a present self, future self, or third person. In the *real* decision condition, however, participants chose a smaller quantity for a present self and much larger quantities for a future self or a third person, with no significant differences between the two. Thus, the research demonstrated that people conceive of a future self as though it were a separate person.

CLT: Increasing or Decreasing Base-Rate Neglect?

Relatively little research has been advanced into how psychological distance affects decision-makers use of base-rate and hit-rate information. Ledgerwood, Wakslak and Wang (2010) and Burgoon, Henderson and Wakslak (2013) both obtained evidence that distance results in increased weighting of base-rates. However, Braga, Ferreira, and Sherman (2015) found contradictory evidence—that is, increased weighting of hit-rate information. These studies are now explained in detail.

Ledgerwood, Wakslak, and Wang (2010) tested the idea that distance results in decisions in which abstract information is weighted more heavily than concrete information. The researchers asked participants to imagine they were having trouble sleeping and needed to decide which of two sleeping pills to try. Aggregate information (i.e. a higher efficacy rating) favored drug Y and individualized information (i.e. a recommendation from an acquaintance) favored drug X. While participants showed a general preference for the individualized information, distance modified the weighting of both pieces of information, with a decrease in the weighting of the individuating drug in the distant future. An additional study showed that psychological distance results not only in discounting of individuating information but also favoring of aggregate information. In this study, participants were told to imagine the scenario taking place 1 week or 1 year in the future. They were then presented with purchasing two toasters. The aggregate information favored toaster A but individuating information (i.e. the first review) did not, or that aggregate information did not favor toaster B but individuating information did. They were asked to indicate their willingness to pay for each toaster. Participants paid, on average, more for the aggregate toaster: $5.73 more in the near future and $10.79 more in distant future.

Burgoon, Henderson, and Wakslak (2013) tested how people view decision makers who use aggregate or case-specific information. Participants were told that their congressional representative was interviewed in his or her district office (psychologically proximal) or Washington, D.C. office (psychologically distant). They were then told that their representative was making a decision based either on statistics or case-specific information. Participants used a 7-point Likert scale to rate how likely they were to vote for the representative in the next election. In the spatially distant condition, participants were less supportive of their representative when he or she relied on case-specific information. However, their support for the

representative in the spatially proximal condition was not affected by the representative using aggregate or case-specific information.

Braga, Ferreira, and Sherman (2015) looked at how construal levels affect heuristic judgments. Participants were randomly assigned to a high or low construal level priming manipulation. Under the high construal level condition, participants were asked to imagine themselves one year in the future. Participants in the low construal level condition were asked to imagine themselves one day in the future. Participants in both conditions were asked to list five activities they planned on pursuing at that time. Participants then viewed three personality sketches modeled after the *lawyers and engineers* problem (Kahneman & Tversky, 1973), with descriptions of a hypothetical person consistent with either a stereotypical engineer or lawyer. Each problem stated the number of individuals per occupation in the sample, assigning them to a smaller (10 members) or larger group (90 members). The participants decided if the randomly drawn person belonged either to the smaller or larger group.

The dependent variable was the proportion of responses in which the participant selected the group with the higher base rate. When the description was incongruent with group size, participants were more likely to show base-rate neglect when primed with high than with low levels of construal. That is, an abstract (i.e., far-future rather than near-future) mindset made it more likely for participants to rely on stereotypes to make their decisions.

Braga et al.'s (2015) results indicate that the representativeness heuristic is more likely given greater distance. However, Ledgerwood (2010) and Burgoon (2013) found a greater reliance on aggregate information, at the expense of individuating information, given greater distance. In summary, levels of construal can affect what information is used in judgment and decision-making tasks.

CHAPTER 2: OVERVIEW OF THE PRESENT STUDIES

Distance changes how we mentally construe events and objects. When an object is psychologically distant we focus on its essential and abstract characteristics and when psychologically proximal the characteristics that are peripheral and concrete (Liberman , Sagristano, & Trope, 2002). Just as a heuristic response substitutes an easy answer for a more difficult one, high-level construals rely on an object's central features at the expense of its peripheral features.

But is aggregate, base-rate information abstract or is individuating, hit-rate information abstract? Construal Level Theory is a recent addition to the psychological literature, and it is still early days in applying its principles to research in judgment and decision-making. As mentioned, three studies have attempted to answer this question by using psychological distances (Braga et al., 2015; Burgoon et al., 2013; Ledgerwood et al., 2010), and their results have been contradictory.

The aim of the present research is to investigate the effects of construal level on probability reasoning. In Experiment 1 I attempted a replication of Braga (2015), and, based on his findings, predicted that high levels of construal, and/or psychological distance (as opposed to proximity), will decrease the use of base-rate information. Experiment 2 tested other probability formats in which people tend to rely on representativeness, such as Bayesian inference reasoning, thus evaluating the generalizability of these effects.

Experiment 1

The first experiment was designed to replicate Study 2 of Braga and colleagues (Braga et al., 2015). In this study, the authors primed the participants to be in either a proximal or distal psychological distance mindset after which participants were asked to decide whether a person

belonged to a certain group given the base rate of the group as well as a personality description of the person. In the study that I was attempting to replicate, people relied more upon the abstract information, and were thus more likely to consider the target as a member of the smaller group, when the psychological distance was greater rather than when the distance was smaller.

Method

Participants. The study sample consisted of 102 Bowling Green State University psychology undergraduates aged 18 and older drawn from the SONA pool, an online tool allowing those who need research credit to sign up for studies.

Design. The study consisted of two tasks. Task A—the "Choice" task—employed a 2 x 2 design in which the temporal priming manipulation (present or future) was manipulated between subjects and the congruency of the base-rates (congruent or incongruent) with scenario type was manipulated within subjects. The scenario topic (ethnicity or age) was counterbalanced across the levels of congruency. The dependent variable was the participant's choice: that the target character in the scenario belonged to the majority group or the minority group.

Task B—the "Rating" task—again employed a 2 (temporal priming manipulation [present or future]) x 2 (base-rate congruency [congruent or incongruent]) factorial design. Again, the scenario topic was counterbalanced across levels of congruency. The dependent variable was the participant's rating of the target character in the scenario on a 7-point Likert scale. Response options ranged from indicating high certainty that the target belonged to the majority group or high certainty that the target belonged to the minority group.

Procedure. For a full description of the procedure for Experiment 1, see Appendix A. Briefly, participants were randomly assigned to either the future or present priming manipulation condition. Participants were asked to imagine themselves one year (future) or one day (present)

in the future and imagine their to-do list at the time. They listed five activities and an additional three sentences further describing each activity.

Following the priming manipulation, participants responded to four base-rate problems (i.e. Figure 2, see Appendix A for a full list of the problems used). The base-rate problems presented in the "Choice" and "Rating" tasks were identical, except that in the "Choice" task participants selected from one of two options, while in the "Rating" task participants made a selection on a 7-point Likert scale.

Figure 2. Description of Ryan

A psychologist wrote thumbnail descriptions of 100 participants consisting of 90 forty-year-old persons and 10 seventeen-year-old persons.

The description below was chosen at random from the 100 available descriptions.

Ryan lives in Buffalo. He hangs out with his buddies every day and likes watching MTV. He is a big fan of Green Day and is saving to buy his own car. Which of the following is most likely?

a) Ryan is 40 years old

b) *Ryan is 17 years old.*

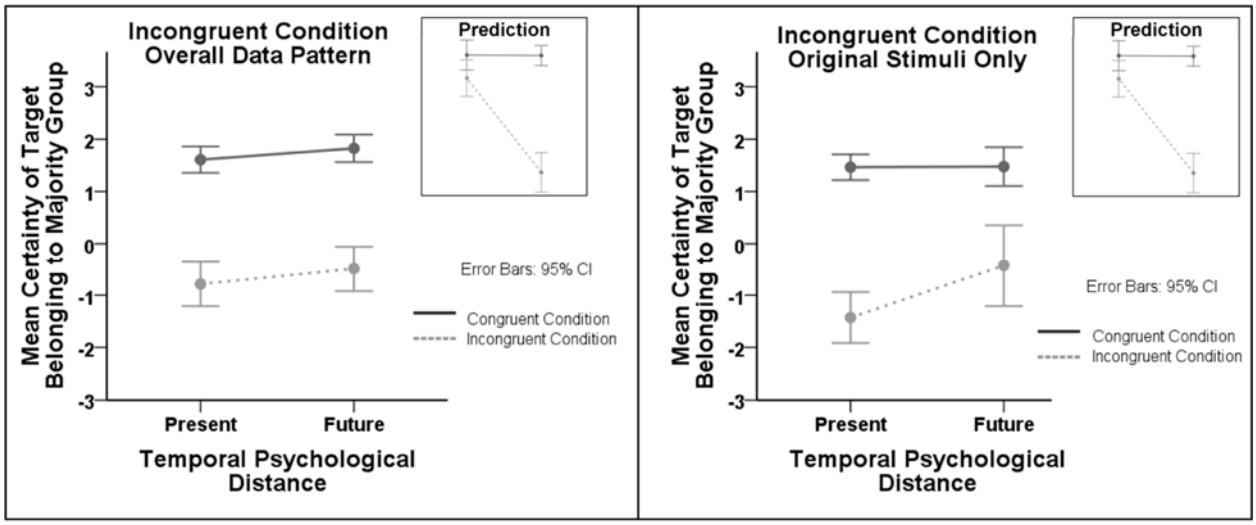
Note. A stimulus used by Braga et al. (2015) in which the description is stereotypical of the smaller group, and participants are asked to select option (A) or (B) to indicate which scenario is more likely. This stimulus is from the "Choice" task.

Results

The data in the "Choice" task (Task A) were coded such that choosing that the target character belonged to the majority group was coded as a "1" while choosing that the target character belonged to the minority group was coded as a "0." In order to analyze the dichotomous data of the Choice task, I constructed a logistic regression analysis, using construal level as a single predictor. The results were not significant for the congruent condition, $\chi^2 = .000$, $p = 1.00$, nor for the incongruent condition, $\chi^2 = .454$, p = .500. Across the incongruent condition, participants slightly favored the target person belonging to the majority group in the future (29.4%) compared to the present (23.5%). However, as discussed below, the experiment contained base-rate conditions that were not present in the experiment I was attempting to replicate. Analyzing solely the base rate conditions present in the original experiment produced significant results $\chi^2 = 4.034$, $p = .045$, with participants again favoring the target person belonging to the majority group in the future (28.6%) compared to the present (7.1%).

The data in the "Rating" task (Task B) were coded such that high certainty that the target character belonged to the majority group was coded as a "+3" while high certainty the target character belonged to the minority group was coded as "-3. I submitted the results to a 2 x 2 factorial analysis of variance (see Figure 3). The effect of the congruency of the base-rates was significant, $F(1, 100) = 203.8$, $p < .001$, $\eta^2 = .671$, however both the effect of time orientation, $F(1, 100) = 1.858$, p = .176, $\eta^2 = .018$, and the interaction, $F(1, 100) = .057$, $p = .812$, $\eta^2 = .001$ were not significant. Again, analyzing solely the conditions in the original experiment, participants were more likely to find the target person in the incongruent condition belonging to the majority group in the future (M = -.429, SD = 1.720) compared to the present (M = -1.429, SD = 1.260), $t(47) = -2.351$, $p = .023$, $d = .663$.

Figure 3. The Results of Experiment 1



Note. The graph on the left shows the overall data pattern, whereas the graph on the right shows the data pattern that includes only the stimuli used by Braga et al. (2015) in the original experiment. An inlay in the upper corner of each graph visualizes the predicted results.

Discussion. Interestingly, the current experiment failed to replicate the original study by Braga et al. (2015): overall, the results were not significant. As mentioned above, however, I also found results that were contradictory. This will be discussed further below.

First, as to the failure to replicate, there are a few reasons why this may have occurred. The first is that I was unable to obtain the complete set of materials used in designing the original experiment. This is true of the priming task, in which I asked participants to consider themselves either in the future or the present, list five things on their "to-do list," and three additional sentences for each of the things on their to do list. The purpose of asking participants to write three additional sentences was to ensure that they were adequately primed and invested in the experiment. However, no index of priming was measured. Previous research has shown that psychological distances share similar semantic meanings. Thus future events are perceived as

being less likely to occur (that is, more hypothetical) (Trope & Liberman, 2010). It is possible that writing three sentences made each item on the to-do list appear more likely and therefore more concrete, negating the temporal manipulation.

Second, and perhaps more importantly, I obtained contradictory results when analyzing solely the base-rate conditions present in the original study. Figure 1, above, was the only question originally used involving Ryan from Buffalo. However, in the present research, I added a condition wherein there was a group consisting of 10 forty-year-olds and 90 seventeen-year-olds. I did the same for the congruent question, effectively creating an incongruent version of it. This was done so as to avoid confounds. Thus, one group saw the original congruent and incongruent questions used by Braga and colleagues, whereas the other group saw a modified version of these questions, making the congruent incongruent and the incongruent congruent by counterbalancing the base-rates. I also removed a neutral condition in which the description was not stereotypic of either base-rate condition.

When I performed an analysis solely on the conditions used by Braga, our results were significant—in the opposite direction of what Braga reported. The explanation that Braga and colleagues gave for their findings of decreased base-rate use was that stereotypical descriptions were a higher level of construal than base-rate information. That is, inducing an abstract mindset made participants more likely to utilize the stereotypical information. They go on to explain that it is their belief that base-rates are not necessarily abstract nor concrete but, rather, must be compared to the existing alternative information. In the problem they used, they argue that a stereotypical description is more abstract, whereas the alternative used by Ledgerwood et al. (2010) and Burgoon et al. (2013) was much more concrete.

However, I would respond that a stereotypical description is not more abstract than the base-rate information. I earlier defined abstraction as a process wherein the central and unchanging features that make up an object are identified. That is, peripheral features are disregarded while the central gist remains. Furthermore, Trope and Liberman (2010) posited that abstract concepts are formed so that operations can be performed on a given object regardless of how psychologically close or distant that object is.

In the problems I and Braga used, the description of the person consisted of specific details of the hypothetical person—concrete details—whereas the composition of the group is important if an operation on the problem is to be performed regardless of distance—an example of abstraction. For instance, the stereotypical lawyer may be culturally specific. A lawyer in Mumbai or Shanghai—that is, in spatially distant locations—may be quite different from lawyers in the United States. Thus, the fact that there are less lawyers in a sample matters more than the fact that the person is described stereotypically as a lawyer.

Experiment 2

Experiment 1 provides preliminary, converging evidence that distance results in greater use of base-rate information at the expense of hit-rate information. Experiment 2 builds upon these findings by extending the problem types used. In the second study I manipulated both psychological distance and level of construal. I sought to improve the effects of psychological distance by incorporating both a priming effect and changing the wording of Bayesian inference problems with precedence in the literature to make the event either psychologically distant or proximal. Based on the results of Ledgerwood et al (2010), Burgoon et al (2013), and the data pattern obtained in the first experiment, I predicted an interaction such that the effect of

psychological distance (versus psychological proximity) on the mean subjective probability rating would be greater under high (versus low) levels of construal.

Method

Participants. Participants were recruited through Amazon MTurk and paid $2 in exchange for completing the experiment. Data from 137 participants was solicited but, following attention checks discussed below, 33 participants were excluded and therefore data from 104 participants was analyzed.

Design. The study was a 2 (construal level [high or low]) X 2 (psychological distance [psychologically distant or psychologically proximal]) X 2 (problem type [mammogram or lawyer]) factorial design, with construal level and psychological distance manipulated between participants and problem type manipulated within participants. The dependent variables were the participant's response to the Bayesian inference questions.

Procedure. The study consisted of four tasks. For a more in-depth discussion of the procedure, which includes all materials used, see Appendix B.

In Task 1, participants were primed in either a high or low construal level mindset by completing the how/why goal priming task (Freitas, Gollwitzer, & Trope, 2004). In this task, participants consider “improving and maintaining one’s physical health.” In the high construal condition they were asked to list 3 ways *why* improving health is important, whereas in the low construal condition participants listed 3 ways *how* they will go about improving and maintaining health.

In Task 2, participants responded to two Bayesian inference problems. Participants answered questions by moving a sliding scale, numbered 0 to 100, to indicate their subjective

probability. Construal level priming was further manipulated by changing wording in the problems so as to make them appear more psychologically distant (or proximal).

The *mammogram* problem was drawn from Gigerenzer and Hoffrage (1995). Figure 4, below, demonstrates the problem type for psychological distance. The problem type for psychological proximity asked participants to imagine a positive screening for a woman "who you do not know well and are not familiar" with.

The *lawyers and engineers* problem was drawn from Kahneman and Tversky (1973). Figure 5 demonstrates the problem type for psychological proximity. The problem type for psychological distance told participants that the event occurred one week ago.

Figure 4. Socially Distant Mammogram Problem

Imagine that the probability of breast cancer is 1% for a woman at age forty who participates in a routine screening. If she has breast cancer, the probability is 80% that she will get a positive mammography. If a woman does not have breast cancer, the probability is 10% that she will still get a positive mammography. Imagine that a woman in this age group who you know well and are familiar with, such as a family member, had a positive mammography in a routine screening. Using the sliding scale below, indicate your subjective probability that this woman actually has breast cancer.

Note. An example of the socially psychologically distant (i.e. occurring to a family member) mammogram problem. Participants made responses by utilizing a sliding scale, ranging from 0 to 100 to indicate their subjective probability. The proximal problem asked participants to provide the subjective probability of breast cancer for a woman "who you do not know well and are not familiar with."

The problems were structured as such because previous research (Wakslak & Trope, 2009) has shown that people make lower probability assessments under high than low construal level mindsets. In the mammogram problem, it is expected that people will have lower probability assessments in the future condition. However, by asking how many lawyers are in the sample, it is expected that participants will make higher probability assessments in the future condition. Thus, using these types of problem will test whether people are focusing on base rates more than diagnostic information, or whether people are simply making lower probability assessments in general.

Figure 5. Temporally Proximal Lawyer Problem

One week ago, our research lab interviewed and administsered personality tests to 30 engineers and 70 lawyers. Based on the interview and personality test, we wrote a thumbnail description of each person. Below is a description of a randomly drawn person.

One week ago, Jack was a 45-year-old man. He was married and had four children. He was generally conservative, careful, and ambitious. He showed no interest in political and social issues and spent most of his free time on his many hobbies, which include home carpentry, sailing, and mathematical puzzles.

What is your subjective probability that one week ago Jack was one of the lawyers in the sample?

Note. An example of the temporally psychologically proximal (i.e. occurring one week ago) lawyers and engineers problem. Participants made responses by utilizing a sliding scale, ranging from 0 to 100 to indicate their subjective probability. The psychologically distant problem stated that our research lab had interviewed and administered personality tests “one year ago.”

In addition, past research (Burgoon, Henderson & Wakslask, 2013) has shown that construal level effects exist regardless of whether the event is perceived as being real (as in the above lawyers and engineers problem) or imagined (as in the mammogram problem). The problems were presented so that one was "real" while the other "imagined" as to minimize interference by making the manipulation transparent (see, for instance, Bar-Hillel, 1980).

Task 3 tested the efficacy of the priming manipulation and changes in wording. Ten of the 25 problems from the Behavior Identification Form (Vallacher & Wegner, 1989) were presented to the participants. The BIF has been previously used in construal level theory research by Liberman and Trope (1998) to assess construal level mindset. In this task, a behavior is listed followed by two alternatives from which the participant must pick. For instance:

1. Making a List
    a) Getting organized
    b) Writing things down

If the priming manipulation and changes in wording were effective, those in the high construal mindset should have been more likely to pick the more abstract option (option a), whereas those in a low construal level mindset should more likely pick the more concrete option (option b).

Task 3 also contained an attention check, asking participants to specifically select one of the two presented answers.

In Task 4 participants answered questions regarding their knowledge of research on Bayesian inference. Finally, participants were debriefed.

Results

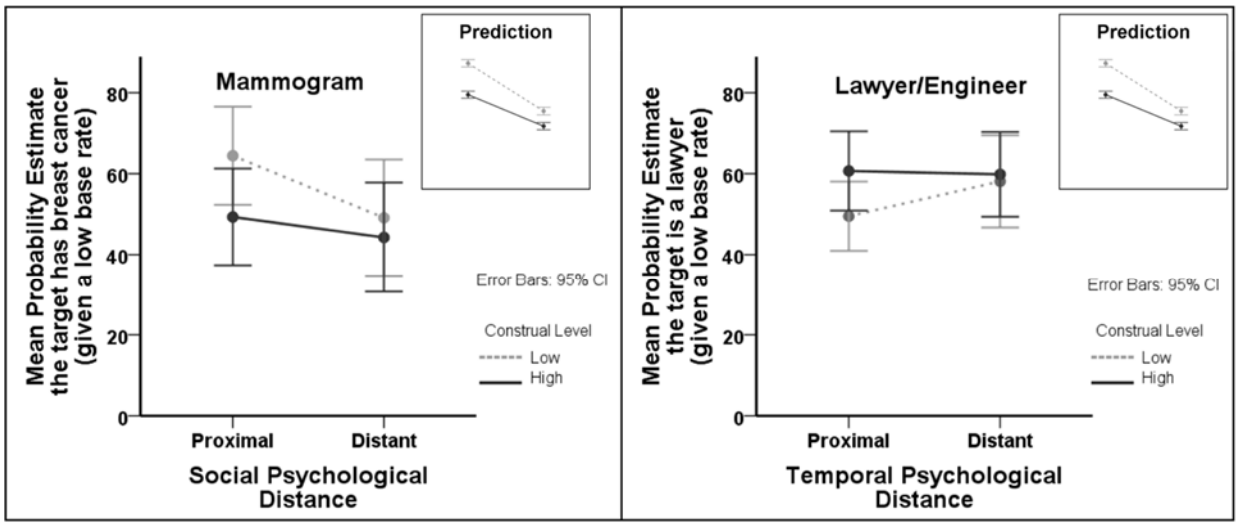
Before I conducted analyses, I checked that participants had passed the attention check in Task 3 and had reported having no previous base-rate experience in Task 4. If they failed either test, their data was not included for analysis. This required collecting additional participants to ensure an equal number was assigned to each of the four groups.

The data in the lawyer and engineer problem were recoded, such that for each score provided by the participant I subtracted it from 100 and took the absolute value of it. This was done because a low score in the mammogram problem indicated a decision relying upon the base-rate information, whereas a low score in the lawyer and engineer problem indicated a decision relying upon the stereotypical description of an engineer.

My predictions were that significant differences would exist when comparing the high construal, psychologically distant group with the low construal, psychologically proximal group. No predictions were made about the low construal, psychologically distant group or the high construal, psychologically proximal group, since prior research (Trope & Liberman, 2010) has shown that high levels of construal activate psychological distance and vice versa. These additional groups were added to avoid confounds.

The results were submitted to a 2 x 2 factorial between-subjects ANOVA (see Figure 6). In the mammogram problem, neither construal, $F(1, 100) = 2.496$, $p = .117$, $\eta^2 = .024$, nor distance, $F(1, 100) = 2.595$, $p = .110$, $\eta^2 = .025$, nor the interaction $F(1, 100) = .657$, $p = .420$, $\eta^2 = .007$, were significant. In the lawyer and engineer problem, neither construal, $F(1, 100) = 1.722$, p = .192, $\eta^2 = .017$, nor distance, $F(1, 100) = .628$, $p = .430$, $\eta^2 = .006$, nor the interaction, $F(1, 100) = .923$, $p = .339$, $\eta^2 = .009$, were significant.

Figure 6. The Results of Experiment 2



Note. The graph compares the results of the mammogram problem and the lawyer/engineer problem under levels of construal and psychological distance. Again, an inlay in the upper corner of each graph visualizes the predicted results.

However, because I predicted significant differences only between two groups, further analyses were conducted. A t-test on the mammogram problem comparing the high construal, psychologically distant group (M = 44.26, SD = 34.286) with the low construal, psychologically proximal group (M = 64.44, SD = 29.353) was significant, $t(50) = -2.271$, $p = .027$, $d = 0.632$. A t-test on the lawyer & engineer problem comparing the high construal, psychologically distant group (M = 40.15, SD = 26.450) with the low construal, psychologically proximal group (M = 50.48, SD = 20.705) was nonsignificant, $t(50) = -1.560$, $p = 0.125$, $d = 0.622$.

The items on the Behavioral Identification Form were analyzed for reliability and found to be internally consistent, $\alpha = .839$, similar to the internal consistency of the original scale, $\alpha = .85$ (Vallacher & Wegner, 1989). (When the attention check was added to the analysis, the

overall scale reliability fell to α = .790.) To analyze the results of the Behavioral Identification Form, I coded an abstract response as a +1, and a concrete response as a -1. The differences between the high construal, psychologically distant (M = 2.148, SD = 4.258) and the low construal, psychologically proximal group (M = 1.520, SD = 6.090) were not significant $t(50) = -0.434$, $p = 0.666$.

Discussion. I had predicted that psychological distance and high levels of construal would cause participants to weigh base rates more heavily compared with psychological proximity and low levels of construal. While only the social psychological distance presented in the mammogram problem had an effect (i.e. the temporal psychological distance paired with the lawyer and engineer problem was nonsignificant), the effect was in the predicted direction: in the psychologically distant scenario, compared with the psychologically proximal scenario, participants made probability assessments more in line with the base-rate information. However, as discussed below, the nature of the problem I used does not allow us to conclude if those decisions were weighing base-rates more heavily or simply finding the event to be less likely to occur.

General Discussion

Across two experiments I tested the idea that psychological distance affects the level at which people construe problems of Bayesian inference. In the first experiment I failed to replicate prior research (Braga et al., 2015) that showed the representativeness heuristic (i.e. base-rate neglect) was more likely given high levels of construal. In Experiment 1, overall I obtained null results. However, when analyzing only the stimuli used in the original research my results were contradictory. These contradictory findings are in agreement with other research (e.g. Burgoon et al., 2013; Ledgerwood et al., 2010): Namely, given high levels of construal,

people are more likely to utilize aggregate information at the expense of individualized information (i.e. less base-rate neglect). This data pattern was also obtained in the mammogram problem used in the second experiment.

Given that past research makes conflicting predictions, the question arose: Do high levels of construal increase or decrease base-rate use? My current results do not allow me to answer the question, but they do provide preliminary evidence of the former. In the first experiment, analyzing solely the conditions used by Braga, my data indicated high levels of construal resulted in decisions more in line with base-rate information compared with low levels of construal in the lawyer & engineer problem. These results were contradictory and opposite to his (Braga et al., 2015) findings but provided converging evidence of other research (Burgoon et al., 2013; Ledgerwood et al., 2010). In the second experiment, high levels of construal, as well as psychological distance, also increased base-rate use in the mammogram problem, compared with psychological proximity and low levels of construal.

If psychological distance does increase use of base-rate information, participants, in the second experiment, should have made lower judgments of probability for the mammogram problem and, prior to data rescoring, higher judgments of probability in the lawyer & engineer problem relative to those in the psychological proximity condition. This is because in the mammogram problem the base-rate was low—1%—whereas in the lawyer and engineer problem the base-rate was high—70%—for lawyers. However, because the results of only the mammogram scenario was significant, I cannot conclude that people are more heavily weighing base-rates or if they simply find psychologically distant (or more abstract) events as being less likely to occur.

Further experiments will need to be conducted in order to assess whether participants are simply making smaller inference judgments when psychologically distant from an event, or whether they are, in fact, making decisions more in line with the base-rate information.

Limitations

A major limitation is distance confound present in the second study. The mammogram problem utilized social distance, whereas the lawyer & engineer problem utilized temporal distance. A follow-up study could test each problem type, and distance type, separately.

Likewise, only temporal and social psychological distances were tested. Spatial and hypothetical distances were not. Hypothetical distances may make interesting predictions. Although previous research has shown that distances do not build upon one another (Maglio, Trope & Liberman, 2013), would changing the occurrence of breast cancer in the population, or the proportion of the occupations in a sample of lawyers and engineers, change people's subjective probability ratings, given that the event is also occurring psychologically distant or proximal?

The effects of differential base-rate weighting may also be a product of the alternative information, as hypothesized by Braga et al. (2015). Later research could test the effect of base-rate, and hit-rate, weighting given psychological distance when either of these types of information is presented absent the other. This would be a perhaps purer test of how either type of information is treated given psychological distances.

Finally, as mentioned previously, I cannot conclude if participants are simply making smaller inference judgments when psychologically distant from an event, or whether they are making decisions more in line with the base-rate information. Further research should test both

high and low base-rates to obtain further evidence of the underlying psychological mechanism causing differential information use.

REFERENCES

Bar-Anan, Y., Liberman, N., & Trope, Y. (2006). The association between psychological distance and construal level: evidence from an implicit association test. *Journal of Experimental Psychology: General*, *135*(4), 609.

Bar-Anan, Y., Liberman, N., Trope, Y., & Algom, D. (2007). Automatic processing of psychological distance: evidence from a Stroop task. *Journal of Experimental Psychology: General*, *136*(4), 610.

Bar-Hillel, M. (1980). The base-rate fallacy in probability judgments. *Acta Psychologica*, *44*(3), 211-233.

Barbey, A. K., & Sloman, S. A. (2007). Base-rate respect: From ecological rationality to dual processes. *Behavioral and Brain Sciences*, *30*(03), 241-254.

Bayes, & Price, M. (1763). An Essay towards solving a Problem in the Doctrine of Chances. By the late Rev. Mr. Bayes, FRS communicated by Mr. Price, in a letter to John Canton, AMFRS. *Philosophical Transactions* (*1683-1775)*, 370-418.

Braga, J. N., Ferreira, M. B., & Sherman, S. J. (2015). The effects of construal level on heuristic reasoning: The case of representativeness and availability. Decision, 2(3), 216-227.

Burgoon, E. M., Henderson, M. D., & Markman, A. B. (2013). There Are Many Ways to See the Forest for the Trees A Tour Guide for Abstraction. *Perspectives on Psychological Science*, *8*(5), 501-520.

Burgoon, E. M., Henderson, M. D., & Wakslak, C. J. (2013). How do we want others to decide? Geographical distance influences evaluations of decision makers. *Personality and Social Psychology Bulletin*, 0146167213481247.

De Neys, W. (2006). Dual processing in reasoning two systems but one reasoner. *Psychological science*, *17*(5), 428-433.

Eddy, D. M. (1982). Probabilistic reasoning in clinical medicine: Problems and opportunities. In Kahneman, D., P., & Tversky, A., *Judgment Under Uncertainty: Heuristics and Biases* (249-267). New York, NY: Cambridge University Press

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American psychologist*, *49*(8), 709.

Evans, J. S. B. (1989). *Bias in human reasoning: Causes and consequences*. Lawrence Erlbaum Associates, Inc.

Evans, J. S. B., & Curtis-Holmes, J. (2005). Rapid responding increases belief bias: Evidence for the dual-process theory of reasoning. *Thinking & Reasoning*, *11*(4), 382-389.

Evans, J. S. B., Handley, SJ, Over, DE, & Perham, N. (2002). Background beliefs in Bayesian inference. *Memory and Cognition*, *30*, 179-190.

Evans, J. S. B., Handley, S. J., Perham, N., Over, D. E., & Thompson, V. A. (2000). Frequency versus probability formats in statistical word problems. *Cognition*, *77*(3), 197-213.

Fischhoff, B., & Bar-Hillel, M. (1984). Diagnosticity and the base-rate effect. *Memory & cognition*, *12*(4), 402-410.

Freitas, A. L., Gollwitzer, P., & Trope, Y. (2004). The influence of abstract and concrete mindsets on anticipating and guiding others' self-regulatory efforts. *Journal of experimental social psychology*, *40*(6), 739-752.

Gigerenzer, G., & Hoffrage, U. (1995). How to improve Bayesian reasoning without instruction: frequency formats. *Psychological review*, *102*(4), 684.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, *74*(6), 1464.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. *Heuristics and biases: The psychology of intuitive judgment*, *49*.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology*, *3*(3), 430-454.

Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological review*, *80*(4), 237.

Ledgerwood, A., Wakslak, C. J., & Wang, M. A. (2010). Differential information use for near and distant decisions. *Journal of Experimental Social Psychology*, *46*(4), 638-642.

Liberman, N., Sagristano, M. D., & Trope, Y. (2002). The effect of temporal distance on level of mental construal. *Journal of experimental social psychology*, *38*(6), 523-534.

Liberman, N., & Trope, Y. (1998). The role of feasibility and desirability considerations in near and distant future decisions: a test of temporal construal theory. *Journal of personality and social psychology*, *75*(1), 5.

Maglio, S. J., Trope, Y., & Liberman, N. (2013). Distance from a distance: Psychological distance reduces sensitivity to any further psychological distance. *Journal of Experimental Psychology: General*, *142*(3), 644.

Nisbett, R. E., & Borgida, E. (1975). Attribution and the psychology of prediction. *Journal of Personality and Social Psychology*, *32*(5), 932.

Novemsky, N., & Kronzon, S. (1999). How are base-rates used, when they are used: A comparison of additive and Bayesian models of base-rate use. *Journal of Behavioral Decision Making*, *12*(1), 55-67.

Pronin, E., Olivola, C. Y., & Kennedy, K. A. (2008). Doing unto future selves as you would do unto others: Psychological distance and decision making. *Personality and Social Psychology Bulletin*, *34*(2), 224-236.

Sloman, S. A. (1996). The empirical case for two systems of reasoning. *Psychological bulletin*, *119*(1), 3.

Sloman, S. A., Over, D., Slovak, L., & Stibel, J. M. (2003). Frequency illusions and other fallacies. *Organizational Behavior and Human Decision Processes*, *91*(2), 296-309.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of experimental psychology*, *18*(6), 643.

Tversky, A., & Kahneman, D. (1982) Evidential impact of base rates. In Kahneman, D., Slovic, P., & Tversky, A., *Judgment Under Uncertainty: Heuristics and Biases* (249-267). New York, NY: Cambridge University Press

Tversky, A., & Kahneman, D. (1983). Extensional versus intuitive reasoning: the conjunction fallacy in probability judgment. *Psychological review*, *90*(4), 293.

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological review*, *117*(2), 440.

Vallacher, R. R., & Wegner, D. M. (1989). Levels of personal agency: Individual variation in action identification. *Journal of Personality and Social Psychology*, *57*(4), 660.

Wakslak, C., & Trope, Y. (2009). The effect of construal level on subjective probability estimates. *Psychological Science*, *20*(1), 52-58.

APPENDIX A: FULL PROCEDURE FOR EXPERIMENT 1

Experiment 1 was designed using Qualtrics survey software. Participants were randomly assigned to one of two conditions: the present condition and the future condition. In the present condition, participants were asked to imagine themselves tomorrow, and write a total of five activities from their to-do list at that time. After listing an activity, they were prompted to write three additional sentences to further describe the activity.

In the future condition, participants were asked to imagine themselves next year, and write a total of five activities from their to-do list at that time. After listing an activity, they were prompted to write three additional sentences to further describe the activity.

Following the priming manipulation, participants responded to four base-rate problems. They first responded to two randomly presented "Choice" questions. Next, they responded to two randomly presented "Rating" questions. Each participant viewed four total problems: two for which they were asked to make a choice between two options (the "Choice" task) and two for which they were asked to make a selection on a 7-point Likert scale (the "Rating" task).

- *There are 100 people in a room.*
- *90 are Italian.*
- *10 are Swedish.*
- *Marco has been selected at random from the people in the room. Marco is 16 years old. He loves to play soccer with his friends, which they go out for pizza or to someone's house for homemade pizza.*
- *Which of the following is most likely?*
    - *Marco is Italian*
    - *Marco is Swedish*

In addition, each participant viewed the same four problems, except that congruency was counterbalanced across conditions. For instance, one group of participants viewed problems in which 90 people were Italian and 10 were Swedish (in both the "Choice" and "Rating" task) and 90 were forty and 10 were seventeen (in both the "Choice" and "Rating" task), while the other group of participants viewed problems in which 10 people were Italian and 90 were Swedish (in both the "Choice" and "Rating" task) and 10 were forty and 90 were seventeen (in both the "Choice" and "Rating" task).

- *There are 100 people in a room.*
- *10 are forty years old.*
- *90 are seventeen years old.*
- *Ryan has been selected at random from the people in the room. Ryan lives in Buffalo. He hangs out with his buddies every day and likes watching MTV. He is a big fan of Green Day and is saving to buy his own car.*
- *Which of the following is most likely?*
    - *Ryan is 40 years old.*
    - *Ryan is 17 years old.*

APPENDIX B: FULL PROCEDURE FOR EXPERIMENT 2

Task 1

The first task in Experiment 2 was a priming manipulation. Participants were asked to complete the how/why goal priming task previously used by Freitas et al. (2004). Participants were randomly assigned to one of two conditions: either the high ("why") construal level or low ("how") construal level condition.

"How" Priming. In the low construal level condition, participants first viewed a screen of text that stated that for everything we do, there is a process of *how* we do it (see below).

For everything we do, there is always a process of how we do it. Moreover, we often can follow our broad life-goals down to our very specific behaviors.

For example, like most people, you probably hope to find happiness in life. How can you do this? Perhaps finding a good job, or being educated, can help. How can you do these things? Perhaps by earning a college degree. How do you earn a college degree? By satisfying course requirements. How do you satisfy course requirements? In some cases, such as today, you participate in a psychology experiment

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Next, the participants viewed a screen asking them to list an activity that can improve and maintain physical health, and rate, on a 5-point Likert scale, with "very much" at one end and "very little" at the other end, indicating how much engaging in this activity will improve and maintain physical health.

For this thought exercise, please consider the following activity: "improving and maintaining your physical health."

In the space provided below, please list the first way (of three) that you can improve and maintain your physical health.

Finally, participants were asked to provide, for one activity, four progressively more concrete (i.e. "how") ways they could improve and maintain health. For instance, they were asked "How do you improve and maintain health?" and listed, for instance, going to the gym, then asked "How?" they did that, providing a "how" response to each action listed.

"Why" Priming. In the high construal level condition, participants first viewed a screen of text that stated that for everything we do, there is a process of *why* we do it.

For everything we do, there is always a reason why we do it. Moreover, we often can trace the causes of our behavior back to broad life goals that we have.

For example, you currently are participating in a psychology experiment. Why are you doing this? Perhaps to satisfy a course requirement. Why are you satisfying the course requirement? Perhaps to pass a psychology course. Why pass the course? Perhaps because you want to earn a college degree. Why earn a college degree? Maybe because you want to find a good job, or because you want to educate yourself. And perhaps you wish to educate yourself or find a good job because you feel that doing so can bring you happiness in life.

Next, the participants viewed a screen asking them to consider how improving and maintaining physical health can help one meet important life goals and rate, on the same 5-point Likert scale used in the "how" priming, how much engaging in this activity will help them meet important life goals.

Finally, participants were asked to provide, for one activity, four progressively more abstract (i.e. "why") reasons for improving and maintaining health. This procedure was identical to that of the "how" priming task.

Task 2

In Task 2, participants responded to two Bayesian inference problems: the mammogram and the description of "Jack" from the lawyer and engineer problem. The wording of the mammogram problem was manipulated so as either to appear socially distant or socially proximal. The wording of the lawyer and engineer problem was manipulated to appear either temporally proximal or temporally distant. The participants provided their subjective probability of a positive mammogram and Jack being one of the lawyers by moving a sliding scale numbered 0 to 100.

Imagine that the probability of breast cancer is 1% for a woman at age forty who participates in a routine screening. If she has breast cancer, the probability is 80% that she will get a positive mammography. If a woman does not have breast cancer, the probability is 10% that she will still get a positive mammography.

Imagine that a woman in this age group who you do not know and you are not familiar with had a positive mammography in a routine screening.

Using the sliding scale below, indicate your subjective probability that this woman actually has breast cancer.

One year ago, our research lab interviewed and administered personality tests to 30 engineers and 70 lawyers. Based on the interview and personality test, we wrote a thumbnail description of each person. Below is a description of a randomly drawn person.

One year ago, Jack was a 45-year-old man. He was married and had four children. He was generally conservative, careful, and ambitious. He showed no interest in political and social issues and spent most of his free time on his many hobbies, which include home carpentry, sailing, and mathematical puzzles.

What is your subjective probability that one year ago Jack was one of the lawyers in the sample?

Task 3

In the third task, participants were asked to respond to stimuli drawn from the Behavior Identification Form (Vallacher & Wegner, 1989). After viewing the original instructions, participants responded to ten of 25 of the stimuli.

In the third part of the experiment, we are interested in your personal preferences for identifying behaviors. Any behavior can be identified in many ways. For example, one person might describe a behavior as "typing a paper," another as "pushing keys," and yet another as "expressing thoughts." On the following pages you will find several different behaviors listed. After each behavior will be two choices of different ways in which the behavior might be identified. Here is an example.

1. Attending class

a) Sitting in a chair

b) Looking at a blackboard.

Task 4

In Task 4 participants answered questions regarding their knowledge of research on Bayesian inference and were debriefed.