Mood Effects on Stereotype-based Conjunction Probability Judgments of Minorities in Education

An honors thesis for the Center of Interdisciplinary Studies

Emma Rubin Lieberman

Tufts University, 2014

Acknowledgements

First and foremost, I would like to thank my head advisor, Professor Richard Chechile, for his constant encouragement and guidance throughout the process of this thesis. I would also like to thank my two other advisors, Professor Christoph Börgers and Professor Pawan Dhingra, for their support and advice on taking an interdisciplinary approach my thesis. I must also thank Daniel Barch for his assistance during every step of the process from forming a hypothesis to writing the thesis. In addition, I would like to thank Jessica Pfeffer and Kimberly Doan for their patience and support. Lastly, I would like to thank my friends and family for their help.

Abstract

Previous research has proven people commit the conjunction fallacy because of stereotype-use. Additionally, previous research has demonstrated that mood effects stereotype-use. The current study investigates mood effects on stereotype-based conjunction probability judgments under the classical and quantum probability theory. Forty undergraduate participants were randomly assigned to either a sad or neutral mood condition. All participants then answered 32 questions about the probabilities of individuals from difference races and genders experiencing adverse educational outcomes. The results show individuals committed the conjunction fallacy for minority females when under the sad mood condition. Also, individuals tended to commit the conjunction fallacy for minority males when they were under the sad mood condition. There were close to significant results for differences in mood conditions of participants when they made probability judgments about minority females and white females. Lastly, individuals tended to make higher probability judgments under the sad mood condition than under the neutral mood condition. Stereotype-use was demonstrated and the conjunction fallacy was committed. The present results are more consistent with the stereotype-use explanation of the conjunction fallacy.

Mood effects on stereotype-based conjunction probability judgments of minorities in education

There have been a number of types judgments in probability that are inconsistent with probability theory (Bar-Hillel & Neter, 1993; Bodenhausen, 1990; Tversky & Kahneman, 1983). This thesis looks to focus on one of these phenomenons, the conjunction fallacy.

The conjunction fallacy violates Probability Theory, which dictates the relationships between events. The extension rule, one relation, states that if event A includes event B, then $P(A) \geq P(B)$. The probability of the conjunction or intersection of two events cannot be larger than its constituents, or marginal probability. The conjunction rule, part of the extension rule, states that $P(A) \geq P(A\&B)$ and $P(B) \geq P(A\&B)$ (Bar-Hillel & Neter, 1993). The conjunction fallacy occurs when the probability of the conjunction of the two events is judged more probable than one occurring by itself (Tversky & Kahneman, 1983).

The most common example used to demonstrate this judgment error of the conjunction fallacy is the Linda Problem (Tversky & Kahneman, 1983). Participants were given the following description of Linda: thirty-one years old, single, outspoken, very bright, and majored in philosophy. As a philosophy student, she was deeply concerned with issues of discrimination and social justice and also participated in anti-nuclear demonstrations. The description of Linda was purposefully representative of a feminist. Participants were then asked to rank the possibility that Linda matched eight statements based on her description. Three of the statements included Linda as a bank teller (unrepresentative of her description), a feminist (representative of the description), and both a bank teller and a feminist. Between 85% and 90% of participants ranked these three choices in the following order: feminist; bank teller and feminist; bank teller. These judgments are impossible and demonstrate the conjunction fallacy because the probability of

Linda being a bank teller and a feminist (conjunction) cannot be larger than her being a bank teller (marginal). Even the participants, who were in a higher degree program involving statistics, committed the error. Furthermore, participants still committed the error when just comparing bank teller (marginal) with bank teller and feminist (conjunction).

Scholars have debated several explanations for why people commit the conjunction fallacy during probability judgments. The current research will focus on the psychological explanation (Bodenhausen, 1990; Tversky & Kahneman, 1983). However, alternate explanations, including semantics and quantum probability will also be discussed (Hertwig, Benz, & Krauss, 2008; Morier & Borgida, 1984; Wolford, Taylor, & Beck, 1990).

The field of psychology explains that the judgment error occurs because participants relied on heuristics, or mental shortcuts, when comprehending information and making decisions. During Tversky and Kahneman's study, participants used the judgmental heuristic of relying on intuition or rules of thumb to estimate the probability the different descriptions. Specifically, they used the representativeness heuristic, which occurs when one sees something as more plausible because it is similar to stereotypes fitting that description (Bodenhausen, Kramer, Süsser, 1994; Kahneman, 2012). Linda's description makes her representative of a feminist and unrepresentative of a bank teller. Thus, by adding the description of feminist to bank teller, the statement becomes more representative of Linda. The conjunction statement is more plausible (representative), but not more probable.

Probability judgments involve taking into consideration the base-rates, or prior knowledge of the actual frequency, as well as the new information (the description of Linda). In this case, participants do not know the exact amount of feminists, banker tellers, and feminist bank tellers. However, there is always a lower base-rate of feminist bank tellers, than feminists and bank tellers. With added detail, there is less of a chance of the event (feminist bank tellers) occurring, even though it seems more plausible since the statement is more representative of the description of Linda. Claiming that it is more probable that Linda is a feminist bank teller than a bank teller is in violation of the conjunction rule. The probability of Linda being a bank teller has to be greater than or equal to the probability that she is a feminist bank teller.

The Linda problem pits the intuition of representativeness against the logic of probability. The participants' implicit bias, or gut reaction, uses the representativeness heuristic to determine how much the statement matches the representation of Linda based on the original description. The participants' intuition to use the representativeness heuristic is an automatic thought process. However, using the logic of probability is a more analytic and conscious process and, consequently, takes more effort. People commit the conjunction fallacy because their knowledge of probability logic is unable to overcome their automatic, heuristic use (Bodenhousen, 1990).

Research has more specifically proven that participants' use of stereotypes, a heuristic under the representativeness heuristic, could cause them to make the conjunction fallacy (Barch, Schultz, Chechile, & Sommers, 2012; Bodenhousen, 1990). Stereotyping occurs when a person uses overgeneralizations about a group to define a single person (Park & Banaji, 2000). In the case of the Linda problem, people commit conjunction probability because they rely on their stereotypes of feminists when determining the probabilities.

Recent research has proven the use of stereotypes in the Linda problem by determining that manipulating people's stereotype changes their conjunction probability judgments. Barch et al. (2012) examined probability judgments for a social task and a non-social task. They also studied whether completing a non-social task before a social task changed probability judgments. The non-social task is set up similar to the Linda problem (asking about marginal and conjunction probabilities), but there is no social context involved. Participants were asked about the probability of drawing a marble of a specific color and pattern from a can. The social task involved making probability judgments about violent crimes committed by a specific race and gender. The experiment tested whether completing the non-social task before the social task had any effect on participants' probability judgments. Barch et al. found that participants who completed the social task first committed the conjunction fallacy, specifically with minority males and minority females. These judgments appear to be driven by stereotypes. Participants did not make this conjunction error if they completed the non-social task first. Furthermore, participants did not commit the conjunction fallacy for the non-social task. This helps support that the conjunction fallacy is caused by the reliance on stereotypes, and not a misunderstanding of probabilities. Furthermore, the only difference between the non-social and social task was the social context. Consequently, during the non-social task (marbles), participants did not have any stereotypes to rely on and subsequently did not make the conjunction error. This study also proves that participants' reliance on stereotypes can be manipulated with priming in order to aid in probability judgments.

Bodenhousen (1990) also used the Linda problem to measure stereotype use. He proved that the reliance on stereotypes in making probability judgments varies with a person's circadian pattern. The circadian rhythms determined different arousal levels, a person's cognitive awareness. The various arousal levels translate to varying levels of motivation and processing capacity of information. People rely on stereotypes when there is little motivation or processing capacity (Erber & Fiske, 1984; Neuberg & Fisk, 1987). Results showed that people committed the conjunction fallacy less during their optimal functional time than their non-ideal functional time. The psychological explanation, the focus of research in this paper, uses stereotype-use to reason the judgmental error in conjunction probability judgments in a social context.

The current research looks at how mood affects stereotype-use in conjunction probability judgments. Interactions and decisions never occur or are made in isolation. Numerous factors, like mood, will affect one's thinking and behavior. Specifically, happiness and sadness effect social cognition through various mechanisms. It is believed that mood can affect ones thinking in two different ways. First, there are the information effects of mood, meaning mood affecting what people think. Secondly, mood can affect the process of cognition, or how people think (Chan, 2005). There are several theories on affect and the cognitive process, including mood-as-information, mood-and-general-knowledge, and cognitive capacity models (Park & Banaji, 2000). While these theories dispute the exact mechanisms of social cognition that are affected by mood, the general outcome, mood effecting social cognition, is the same.

The mood-as-information account (Schwarz, 1990) and the mood-and-general-knowledge model (Bless, Clore, et al., 1996; Bless, Schwarz, & Wieland, 1996), explain that mood determines how people interact with their environment and the current situation. In a positive mood state, people are content and thus do not feel immediately threatened: they have no motivation to put cognitive effort into analyzing the current situation. Consequently, people in a happy mood state use effortless, global processing when making judgments (Bodenhausen, Kramer, and Süsser, 1994; Bodenhausen, Sheppard, Kramer, 1994). Happy people do not look at the details of a situation, just the big picture. On the other hand, people in a sad mood, a type of negative affect state, feel threatened by their environment, which indicates that there is an immediate issue. Consequently, people try to solve this problem by thinking very attentively, carefully, and in a detailed-oriented way; i.e. using a lot of cognitive effort (Bless, Schwarz, & Wieland, 1996; Edwards & Weary, 1993; Park & Banaji, 2000; Sinclair, 1988).

These opposing cognition techniques are related to the use of heuristics. People in happy moods are not motivated to use effortful cognitive processes, and thus are more likely to rely on heuristics and use stereotypes. Conversely, people in a negative mood use a systematic way of thinking, and thus do not lean on heuristics to make judgments (Bodenhausen, Kramer, & Süsser, 1994; Bodenhausen, Sheppard, Kramer, 1994).

Much research has been done on happy moods and stereotype use, (e.g., Bodenhausen, Kramer, & Süsser, 1994; Bodenhausen, Sheppard, Kramer, 1994). The present research will look at negative affect on stereotype use. Park and Banaji's (2000) study, examined happy and sad states in stereotyping. During this study, participants were assigned to a negative, neutral, or positive mood. Participants were given of list names and identified whether they were a Black or white, basketball or non-basketball player.

Results indicated that participants in a sad mood used more stringent criterion when making judgments. This means that they were more reluctant before identifying somebody as a basketball player. Sad mood participants were less lenient in their judgments, compared with their neutral and happy mood counterparts. This more broadly implies that people in sad moods reduce their stereotype use, or generalizations of a group to make judgments on a person (Park & Banaji, 2000). This study only led to more questions about further research on the use of heuristics, with regards to sad mood. The present research will explore some of these questions.

In addition to the psychological explanation of the conjunction fallacy, other research has suggested alternate reasoning and models for why people commit the probability judgment errors (Beck, 1990; Busemeyer, Pothos, Franco, & Trueblood, 2011; Hertwig et al., 2008; Hertwig &

Gigerenzer, 1999; Morier & Borgida, 1984; Wolford, Taylor, & Pothos & Busemeyer, 2013). Some research says that the semantics of the question and answers cause people to commit the conjunction fallacy. People find the wording of the problem confusing. Additionally, people's understanding of probability and likelihood vary. For instance, Morier and Borgida (1984) found that participants may have misunderstood the question and thus could not accurately make probability judgments. However, de-biasing the task helps alleviate committing the conjunction fallacy only when participants do not rely on the representativeness heuristic. In another experiment, Hertwig, Benz, and Krauss (2008) demonstrated that participants who committed the conjunction fallacy misunderstood the meaning of *and* in the conjunction probability judgments. If the meaning of *and* is unclear for participants, then they will not be able to accurately assess the conjunction probability judgments because *and* signals a conjunction in probability. They may have misunderstood *and* to indicate chronological order, cause-and-effect relationships, or a group, instead of the intersection of two sets (Bank teller and Feminist).

Quantum probability theory offers another alternate explanation to the conjunction fallacy. When people commit the conjunction fallacy, as demonstrated in the Linda Problem, they violate Probability Theory, and classical probability theory cannot explain why people commit this fallacy. However, quantum probability theory explains that this is in fact not an error because participants' judgments are predictable under quantum probability (Pothos & Busemeyer, 2013). Quantum probability theory takes into consideration context-and order-dependence in the cognitive process (Houston & Wiesner, 2013). Both classical and quantum probability believe that cognition can be explained from a probability point of view. However, they are founded on different axioms. Classical probability relies on the Kolmogorov axioms (Kolmogorov, 1933) and quantum probability relies on the Dirac/von Neumann axioms (Dirac, 1930; von Neumann, 1932). This difference is the basis for their differing views of the conjunction fallacy (Pothos & Busemeyer, 2013).

The underlying concepts of the quantum probability theory's explanation of the conjunction fallacy can be demonstrated with two examples. First, is a simple example, where the judger answers the question whether a made-up person is happy or not. Second, a person is given the story of Linda, as described earlier, and asked to judge whether she is a feminist or not. A few quantum probability concepts are needed to understand these problems.

First, probabilities are now represented as vectors. A vector is an entity that has magnitude and direction. A vector space symbolizes all potential answers to a system. To describe happiness, one would look at vector space of all emotions. Happy and not happy would each be one vector. In the example of feminist, the vector space is all the characteristics of Linda. Each vector would be a specific set of characteristics relating to being a feminist.

Any point in the vector space can be defined by a linear combination of the basis vectors. Thus, the basis vectors are the most elementary vectors needed to span the vector space. In the happiness example, the basis vectors are happy or unhappy. In *A Quantum Theoretical Explanation for Probability Judgment,* Busemeyer, Pothos, Franco, and Trueblood (2011) point out that asking if Linda is a feminist brings to mind certain characteristics of feminism, which define an eight dimensional space. In this example, three features are considered: feminist, age, and sexual orientation. Linda is either feminist or not a feminist, young or old, and gay or straight. The first value listed for each feature is what the judger might think after being asked the feminism question. There are many more features about feminism that come to mind, but these three are used to ease the demonstration. Each basis vector consists of a combination of one of the two values for each feature. There are eight combinations and thus eight basis vectors.

For this system the 8 basis vectors are: (feminist, young, gay); (feminist, old, gay); (feminist, young, not gay); (feminist, old, not gay); (not feminist, young, gay); (not feminist, old, gay); (not feminist, young, not gay); (not feminist, old, not gay). These are the vectors that the perceiver uses when answer whether Linda is a feminist or not.

A basis vector represents each feature pattern, which is a specific combination of the features. So, for the feminist question, a feature pattern could be (yes feminist, young, straight) or (no feminist, young, gay). In the happiness example, there is one feature, happiness, with two values: happy or not happy, and thus two feature patterns. This is analogous to cognitive states is psychology.

Within a vector space, there is a subspace, or a group of vectors from the larger vector space. The subspace represents each possible outcome (Pothos & Busemeyer, 2013). For example in the feminist question, the feature pattern (feminist, young, straight) is a subspace of the larger vector space of Linda as a whole, which could also include motherhood, marital status, or living situation.

Each vector space and subspace has a dimensionality. The number of elementary events (Pothos & Busemeyer, 2013), or the number of vectors in the basis determines the dimensionality. Dimensionality in the examples of the feature spaces described are determined by n^m, where *n* is the number of features and *m* is the number of values for each feature. In the feminist example, there are three features, each with two values. Thus, the dimensionality is 2^3, which equals eight dimensions or unique combinations of the values. A ray is a 1-dimensional subspace in the vector space. This is the most elementary answer. In the happiness example, the outcomes to the question are 1-dimensional. One ray represents a person being happy (|happy>) and the other ray represents the person not being happy (|unhappy>).

Also, judgers begin with a belief state, which is their initial knowledge or belief (Busemeyer et al., 2011; Pothos & Busemeyer, 2013). This is represented by the state vector (|Ψ>) and is defined by the linear combination of the basis vectors. An event is an answer to a question about the system, which in the examples is about the feature pattern. The specific answer is represented by a subspace spanned by a basis vector. In the feminist question example, the event of saying yes to "Is Linda a feminist, young, gay person?," is represented by a subspace that is spanned by the basis vector (feminist, young, gay). This basis vector if also a ray in the vector space.

To determine the probability of an event, in this case answering yes to the question, involves projecting the belief state onto the specific feature pattern in question. In the happy example, "Are they happy?," one event is the answer yes to the question. The probability of this event depends on the linear combination of the basis vectors. The belief state is expressed as the linear combination: |Ψ>=a|happy> + b|unhappy>. Thus, the belief state vector depends on the values of a and b, which are called amplitudes, and the length of vector is denoted by double lines (|| |Ψ>||). These two values, a and b, are the components of the state vector along different basis vectors.

In general, the participant projects their belief state onto each ray. This is done with a projector, which takes the belief state (|Ψ>) and projects it onto the feature pattern in question. The projection expresses how similar the vectors are to each other. Specifically, how much of one of the vectors points in the same direction as the other. The mathematical computation of an orthogonal projection of one vector onto another is represented in Figure 1. The projection of *v* onto *u* is written as $\text{proj}_u v$. Vector *u* and vector *v* are two vectors that intersect to form the angle θ. A vector component perpendicular to vector *u* is drawn down from vector *v* to vector *u*. This new vector, from the intersection of vector u and vector v to the point where the vector component perpendicular to vector u crosses vector u, is the orthogonal projection of v onto u.

$$\mathrm{Proj}_u v = |v| \cos(\theta)\left(\frac{u}{|u|}\right)$$

The magnitude of this projection vector is $|v| \cos(\theta)$. Multiplying this by the unit vector $\left(\frac{u}{|u|}\right)$, makes the projection vector point in the direction of the vector u. It is important to note that that θ plays a large role in determining the length of the projection. As θ decreases, the cos(θ) increases, and consequently increases the magnitude of projection.

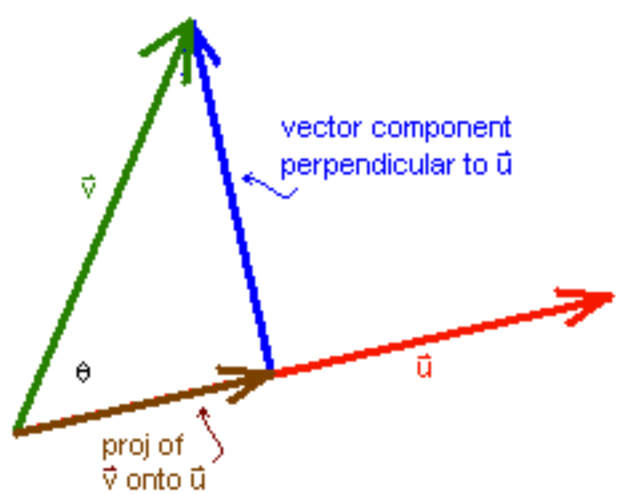

Figure 1. Diagram display of the projection of vector v onto vector u (Downloaded from http://www.math.hmc.edu/calculus/tutorials/vectoranalysis/)

The judged probability for an event, or answering that question for a specific feature pattern, is equal to the squared length of the projection of the belief vector onto the ray of the specific feature pattern. The projection length is equal to the squared magnitude of the amplitude of the projection vector and this is equivalent to the squared correlation.

The question of happiness is a simple example to explain these concepts. Figure 2 depicts the vector space for happiness. The belief state(|Ψ>) is placed in between the |happy> and |unhappy> vectors because it is a linear combination of both. We are concerned about whether the person is happy, thus the projector, P_{happy}, projects the belief state (|Ψ>) onto the subspace for happy. This subspace is spanned by the vector |happy>. The projection is written as ($P_{happy}|\Psi>$), which is equal to a|happy>. The probability that the person is happy is the squared length of this projection or $||P_{happy}\ |\Psi>||^2=|a|^2$. The happier the person is, the larger the amplitude of $P_{happy}\ |\Psi>$ will be. In addition, the belief state will be closer to the basis vector |happy>. This is because the angle between the belief state and |happy> will be smaller in order for the cos (θ) to be larger.

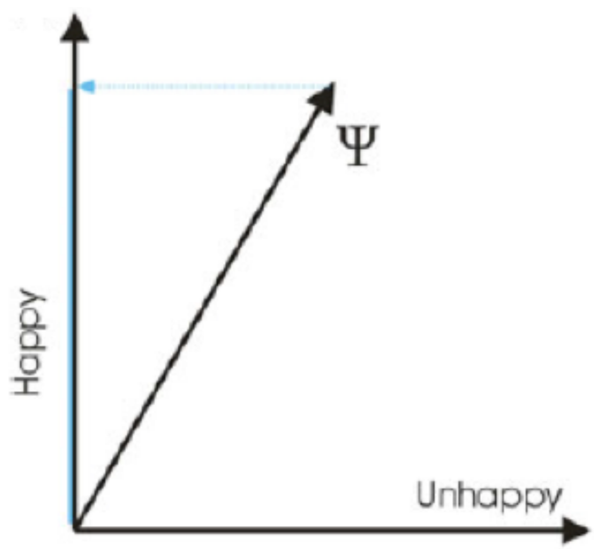

Figure 2. The depiction of the quantum probability process of answering whether somebody is happy or not. The belief state is projected onto the happy subspace. In order to illustrate the problem easier, being happy is represented with one-dimensional subspaces, even though happiness is actually represented with multi-dimensional subspaces. Adapted from Pothos & Busemeyer (2013).

The question of whether Linda is feminist is analogous. The belief state vector is projected onto the subspace for feminism, which does not include the feature patterns that contain the value not feminist [(not feminist, young, gay); (not feminist, old, gay); (not feminist, young, not gay); (not feminist, old, not gay)]. The belief state vector is projected onto the four feature patterns that include feminist: (feminist, young, gay); (feminist, old, gay); (feminist, young, not gay); (feminist, old, not gay). The judged probability for Linda being a feminist is the sum of the squared lengths of all these projections or their squared amplitudes

Unique to quantum probability is the idea of superposition. Before a decision is made, the belief state is in superposition of each of the possible outcomes. For instance, consider the happy example. In classical probability, one is either completely happy, or completely unhappy. The judger does not know, so probabilities are assigned to both. In quantum probability theory however, one is neither happy nor unhappy, they are in an indefinite state. Eventually a decision is made and the superposition state becomes a definite basis state (Busemeyer et al., 2011; Pothos & Busemeyer, 2013). Decisions are based on the context of the situation and the question (Aers & Aerts 1995; Johnson, Haubl, & Keinan, 2007; Shafer & Tversky 1985).

Another one of the distinguishing characteristics of the quantum probability is the issue of compatibility in terms of conjunction questions. If a question is compatible, than it is possible to define the conjunction of two questions, A and B, about a system. If this is the case, classical probability is used to model the problem. Classical probability, however, cannot explain an incompatible question. If a question is incompatible, than it is impossible to answer the conjunction question. Answering question A puts question B in a superposition state. This means that at a certain point in time if A is true, B is consequently neither true or false. This occurs because if A and B are defined by different basis vectors, then their conjunction cannot be answered. It is hard for the judger to have a single thought for the conjunction of A and B if the two questions are very different. Judgers have to think about it sequentially, thus leading to order effects. Order effects occur when judgments are different when A is presented before B, then when B is presented before A.

The conjunction question of Linda being a feminist and a bank teller is incompatible. The judger has no experience thinking of feminism and profession together. Feminist has a different set of features and basis vectors than profession. For instance, profession evokes the thought of the features professions (values: bank teller, doctor, insurance agent and computer programmer) and salary level (values: low/high). These set of features are different than the set of feminist features. None of the basis vectors are the same. A higher dimensional space would be needed to make the two sets of features compatible: a (2*2*2)(4*2)=64 dimensional space. Each basis vector would be a combination of the five features. However, thinking about a low-dimension incompatible vector space is more efficient for thinking.

Instead, the judger must think about the feminist and bank teller sequentially. This process is depicted in Figure 3. First, the belief state is projected onto the feminist vector. This projection is then projected onto the bank teller vector. The question of which trait to evaluate and project the belief state onto first arises. In this case, feminism is evaluated first. There are three rationales for which is chosen first. First, feminism matches the Linda story better, making the feminism features quicker to retrieve. Since they are quicker to retrieve, they can be evaluated more quickly. The second is that the judger conforms to confirmation bias. They answer the questions that will be confirmed first (Wason, 1960). Third, the most important cues are considered first in probability conclusions (Gigerenzer & Goldstein, 1996).

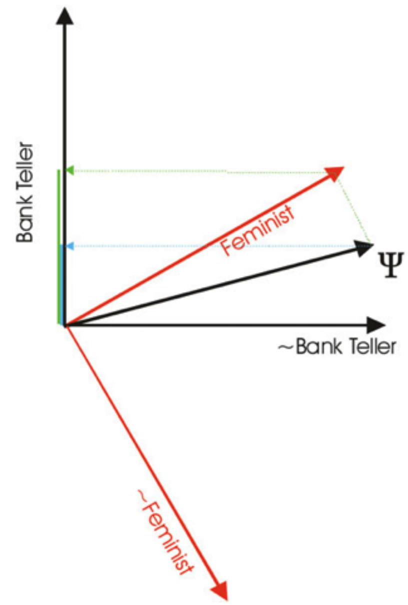

Figure 3. Diagram for Quantum Probability explanation for the Linda Problem. Adapted from Pothos & Busemeyer (2013).

The final concept is state revision. This occurs in the Linda problem because of the incompatibility of the conjunction question and necessity of answering questions sequentially. Answering one question first, transforms the set of basis vectors to another. This involves rotating the axes in the vector space. This translates to changing point-of-views after answering a question. The first step in state revisions occurs when the belief state vector is projected onto the subspace that represents the event that is true. It has a unit length because it is divided by the length of projection. This new projected vector, called the conditional state vector, from the transformation is the new point-of-view for the next projection or event. The conditional state vector is the starting point to answer following questions.

In the Linda problem, when asked about the conjunction question of the probability of her being a feminist and a bank teller, the judger thinks about her being a feminist first. The belief state vector is projected onto the subspace representing yes to feminism. This new condition state vector is denoted ($P_{feminist}$ |Ψ>). All of the amplitudes of these basis vectors are divided by the length of the projection. This gives the conditional state vector unit length. The squared magnitudes of the new amplitudes under the new conditional state vector sum to 1, because they were divided by the length of the projection. Based on the new conditional state vector, the judger answers the probability of her being a bank teller. This is done by projecting the conditional state vector ($P_{feminist}$ |Ψ>) onto the bank teller subspace. The judged probability of Linda being a feminist and a bank teller is the squared length of this projection (Busemeyer et al., 2013).

The concepts described above combine to form the quantum probability theory explanation of the conjunction fallacy. Figure 3 illustrates why the judger determines the probability of Linda being a feminist and a bank teller greater than a bank teller. Each of the vectors are laid out in this format because of the relationship to each other. The bank teller and not bank teller basis vectors, as well as feminist and not feminist basis vectors, are orthogonal because they are the basis vectors. The feminist basis vector, (|feminist>), is close to neither (|bank teller>) nor (|not bank teller>) because being a feminist does not conclude anything about being a bank teller or not. The position of the state vector (|Ψ>), depends on description of Linda given. Thus, (|Ψ>) does not go in between (|bank teller>) and (|feminist>) because then the angle between the (|Ψ>) and (|bank teller>) would be small, meaning a large projection onto the bank teller subspace. However, this is not representative of the Linda story. Thus, (|Ψ>) is on the other side of the (|feminist>), which allows a large projection only onto the feminist subspace. As previously described, the (|Ψ>) is first projected onto (|feminist>). The projection results in a new conditional state vector, that is then projected onto (|bank teller>). As depicted in Figure 3, the amplitude of the projection of the belief state is greatest on (|feminist>), followed by projecting onto (|bank teller>) via (|feminist>), and lastly projection just onto (|bank teller>). This ordering of amplitudes reflects the ranking of probabilities judgers give of each scenario.

The psychological explanation is that it is hard to think of Linda as a bank teller. Projecting the belief state onto the feminist subspace, loses the characteristics of Linda that did not allow the judger to picture Linda has a bank teller. Pothos and Busmeyer (2013) describe this as an abstraction process. After this process, the judger is thinking of Linda as a bank teller, given that she is a feminist. Taking the feminist point-of-view from the state revision makes it easier to picture Linda as a bank teller.

The process described accounts for the representativeness heuristic. The projections used to calculate the probabilities measure how much the two vectors overlap. This overlap is a measure of similarity. Taking the point-of-view of Linda as a feminist allows the cognitive system to see the similarities between the initial representation given in the Linda story and the representation of bank teller. Representativeness heuristic is a similarity process and quantum probability as described models this similarity process.

Busemeyer, Trueblood, Pothos, and Franco (2011, 2013) have demonstrated how the quantum probability model can explain the responses made by individuals. The current research looks to add the relationship of mood with the conjunction fallacy. It is possible that mood could influence the location of the initial belief state in relation to the basis vectors. Mood could also affect the degree to which the basis vectors are rotated. However, the current research relies on the classical framework to assess conjunction errors as an index of stereotype-use as a function of mood.

Method

Participants

Forty students (20 males, 20 females, M_{age}=18.85, age range: 18-22 years) at Tufts University participated in this study as a course requirement. Twenty-four participants identified as white, 6 as Asian, 3 as Black or African-American, 2 as South Asian, 1 as Filipino, 1 as Hispanic, 1 as Afrolatina, 1 as white and Asian, and 1 did not respond. They were recruited through SONA, where participants sign up for studies online. Students were randomly assigned to either a neutral condition or negative condition.

Materials

Two Dell desktop computers were used to run the experiment. The first computer ran the assigned movie clips, which were shown through Windows Movie Player. The movies were *The Champ* (1979), *Hannah and Her Sisters* (1986), and *Tommy Boy* (1995). Participants used noise-canceling headphones while watching the movie clips, and took them off when finished. The second computer was used to administer the probability and demographic questions without the use of headphones. This was done using *E-Prime* (Psychological Software Tools, Inc., Pittsburgh, PA), a user-friendly program specifically for experiments, including the collection of data. *E-Prime* is built to work with PC's.

Procedure

Participants were given the consent form, which stated that the study examined people's probability judgments in different mood states. After consenting, participants watched their assigned movie clip to induce the associated mood condition. The first participant was given the neutral condition, the second was given the negative condition, the third was given the neutral condition, etc. Participants were given headphones to watch a movie clip that will induce either a negative mood condition or a neutral mood condition. To induce the negative mood condition, participants viewed a short clip from *The Champ* (165s), which depicts a little boy watching his father die after a boxing match. To induce the neutral mood condition, participants watched a brief clip from *Hannah and Her Sisters* (91s), which depicts two girls going shopping. Both of these clips were used to induce their respective moods in previous research and have been validated (Frederickson & Branigan, 2005; Gross & Levenson, 1995). Most recently, Nelson and Schiffrin (2009) used these clips to determine' the impact of mood on stereotyping.

After participants watched the assigned clip, they moved to the adjacent computer to answer the probability questions. They answered a series of thirty-two probability questions of a certain demographic fitting a particular education situation. The demographic was either marginal or conjunction. The marginal categories included male, female, white, or minority. The conjunction categories, both a gender and a race, included white male, white female, minority male, or minority female. Participants were not given a definition of any of these demographic terms. These demographics (marginal and conjunction) were paired with a particular education situation: suspended, did poorly on the SAT's, failed a high school class, never attended a four-year college. For example, in a conjunction question, participants were asked, "Please estimate the probability that a white male was suspended from school?" Or, they could be asked the marginal question, "Please estimate the probability that a minority failed a high school class?" These questions were randomly asked and participants were required to enter a whole-number probability from 1-100 into the E-Prime program. Participants then answered a short demographic survey. Questions asked for race/ethnicity, gender, age, type of high school, and what kind of area their high school was located in.

Following answering the probablity and demographic questions, participants were shown a short comedy video from *Tommy Boy* (290s), which depicts two of the characters attempting to sell items. This movie has been used in past studies (Fedorikhin & Patrik, 2010) to elicit a positive mood. This is done to have participants leave the study back to their original state or an even more positive mood state. Thus, leaving participants better than when they entered the study. Finally, participants were given the debriefing form, which informed them that the purpose of the study was to examine the role of mood in making stereotype-based probability estimations.

Results

We compared the participants' probability judgments across all the questions and between each mood condition, looking specifically for potential conjunction effects. Conjunction probabilities were compared to the associated marginal probabilities. Figures 4-7 display the trend of these differences, along with the standard error of each judgment. There were several findings that appear to be of significance or close to significance from these figures. In order to test whether conjunction fallacy was committed we created 98.69% confidence intervals (see Table 1 and Table 2) and performed several t-tests. Participants in sad mood conditions tended to give higher probability judgments than those in the neutral condition, except for male, minority, and minority male (see Table 1 and Table 2). Participants did not commit the conjunction fallacy for white males (see Figure 4). However, there appears to be a trend of committing the conjunction fallacy for minority male and females, with respect to gender, and between moods for minority females and white females.

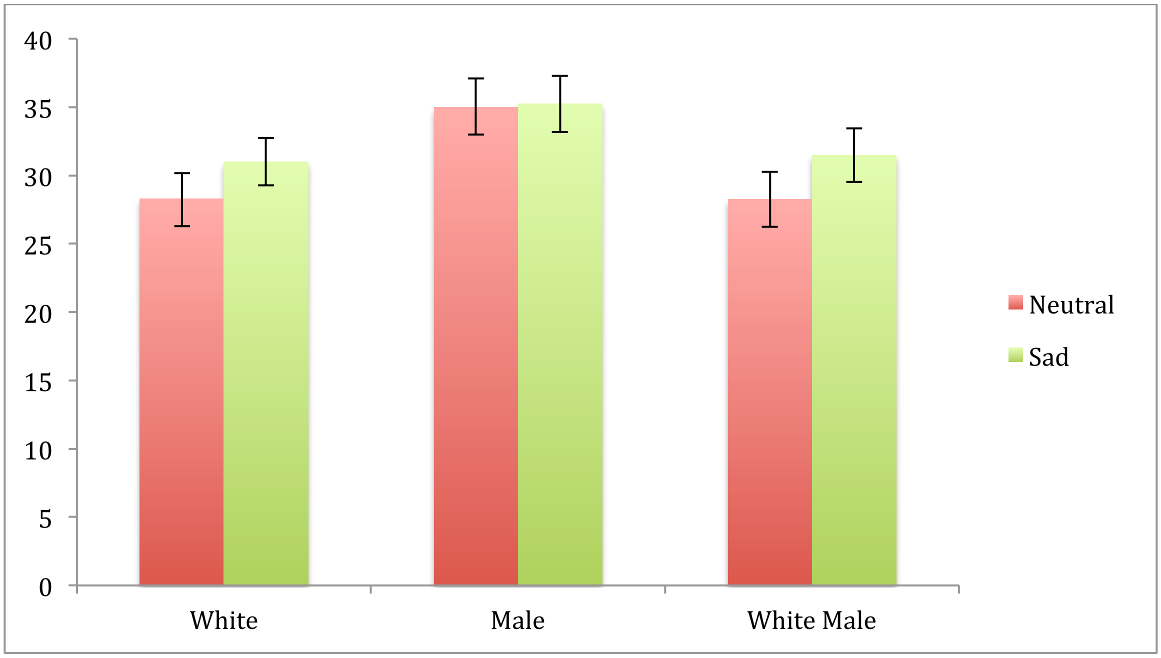

Figure 4. White male conjunction probability estimates and white and male marginal probability estimates by mood prime.

Table 1

*Mean Probability Judgments for All Questions Under Neutral Mood Condition [99.69% Confidence Intervals]**

	White	Minority	Both
Male	28.25	40.475	35
	[22.1312, 34.3689]	[32.9311, 48.0189]	[28.5945, 41.4055]
Female	22.5625	32.475	27.95
	[16.7615, 28.3635]	[25.3676, 39.5824]	[22.1396, 33.7604]
Both	28.3	42.6875	
	[22.5255, 34.0745]	[35.2594, 50.1156]	

*Confidence Intervals Bonferroni adjusted

Table 2

*Mean Probability Judgments for All Questions Under Sad Mood Condition [99.69% Confidence Intervals]**

	White	Minority	Both
Male	31.4875	41.2375	35.2375
	[25.5177, 37.4573]	[33.8841, 48.5909]	[28.9813, 41.4937]
Female	27.1875	37.9875	28.5375
	[22.0927, 32.2823]	[31.3129, 44.6621]	[23.4264, 33.6487]
Both	31	42.275	
	[25.7273, 36.2727]	[36.1106, 48.4394]	

*Confidence Intervals Bonferroni adjusted

First, we examined the conjunction probability judgments of minority females between mood conditions. As depicted in Figure 5, there appears to be a difference between the judgments for minority females given by participants in the sad (M = 37.99) versus neutral (M = 32.475) mood conditions. As demonstrated in Table 1 and Table 2, there is some overlap in the 99.69% confidence intervals between the conjunction probability of minority female given by participants under the neutral condition [25.2676, 39.5824] and sad mood condition [31.3129, 44.6621]. To further test the significance of the difference, we performed a two-tailed independent samples t-test, which showed the difference was not quite significant (t (158) = 1.72, p = 0.0867).

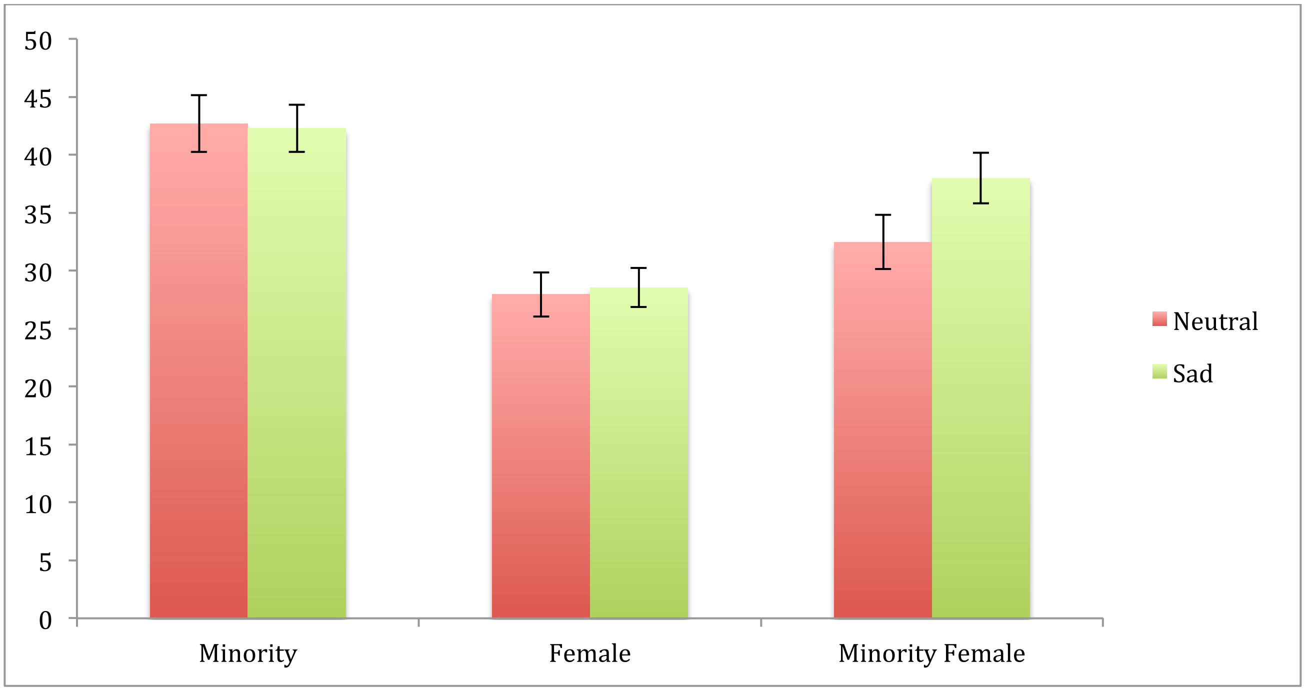

Figure 5. Minority female conjunction probability estimates and minority and female marginal probability estimates by mood prime.

Based on Figure 5, it also appeared that participants tended to commit the conjunction fallacy between female and minority female within each mood condition. Under the neutral mood condition (Table 1), participants said minority females (*M*=32.475) were more likely than all females (*M*=27.95) to have experienced a negative education outcome. However, their confidence intervals overlap, 99.69% CIs [25.2676, 39.5824] and [22.1396, 33.7604], respectively (see Table 1). In order to further test any significance, we performed a *t*-test. It should be noted that no *t*-test is perfect, as it would require a mixed-design approach. Under the independent *t*-test, there was no significant difference between participants' female and minority female probability judgments under the neutral mood condition (t (158)=1.50, $p=0.1349$). The conjunction fallacy was not committed at statistically significant amount for probability judgments of minority females when participants were in the neutral condition.

Results presented in Figure 5 may also demonstrate that participants under the sad mood condition gave probability judgments about female (*M* = 28.5375) and minority females (*M* = 37.9875) that were significantly different. Their respective 98.69% CIs [31.3129, 44.6621] and [23.4264, 33.6487], overlap slightly (see Table 2). This is meaningful considering the large spread of the confidence interval due to the high confidence and low sample size. Under the independent *t*-test, the difference between neutral mood participants' probability judgments for female and minority female were statistically significant ($t(158) = 3.43$, $p = .0008$). Thus, participants under the sad mood condition committed the conjunction fallacy a significant amount.

Figure 6 illustrates potential for participants to commit the conjunction fallacy with respect to minority males and males in each of the mood conditions. Under the neutral mood condition, participants said minority males (*M* = 40.475) were more likely than males (*M* = 35) to have experienced a negative education outcome (see Table 1). Their confidence intervals overlap, 99.69% CIs [32.9311, 48.0189] and [28.5945, 41.4055], respectively (see Table 1). To further test the significance of the difference we performed a *t*-test, which revealed that neutral mood participants' probability judgments for male and minority male were not statistically significant ($t(158) = 1.58$, $p = .1169$).

Results represented in Figure 6 also indicate a difference between participants under the sad mood condition to commit the conjunction fallacy for minority males and males. These participants said minority males (*M* = 41.2375) were more likely than males (*M* = 35.2375) to have experienced a negative education outcome (see Table 2). However, their 99.69%

confidence intervals overlap, [33.8841, 48.5909] and [28.9813, 41.4937], respectfully (see Table 2). A t-test was performed to further test for any significance. Results indicated that there was no statistically significant difference in the probability judgments for minority males and males, however the results are close to significant ($t(158) = 1.89$, $p = .0599$).

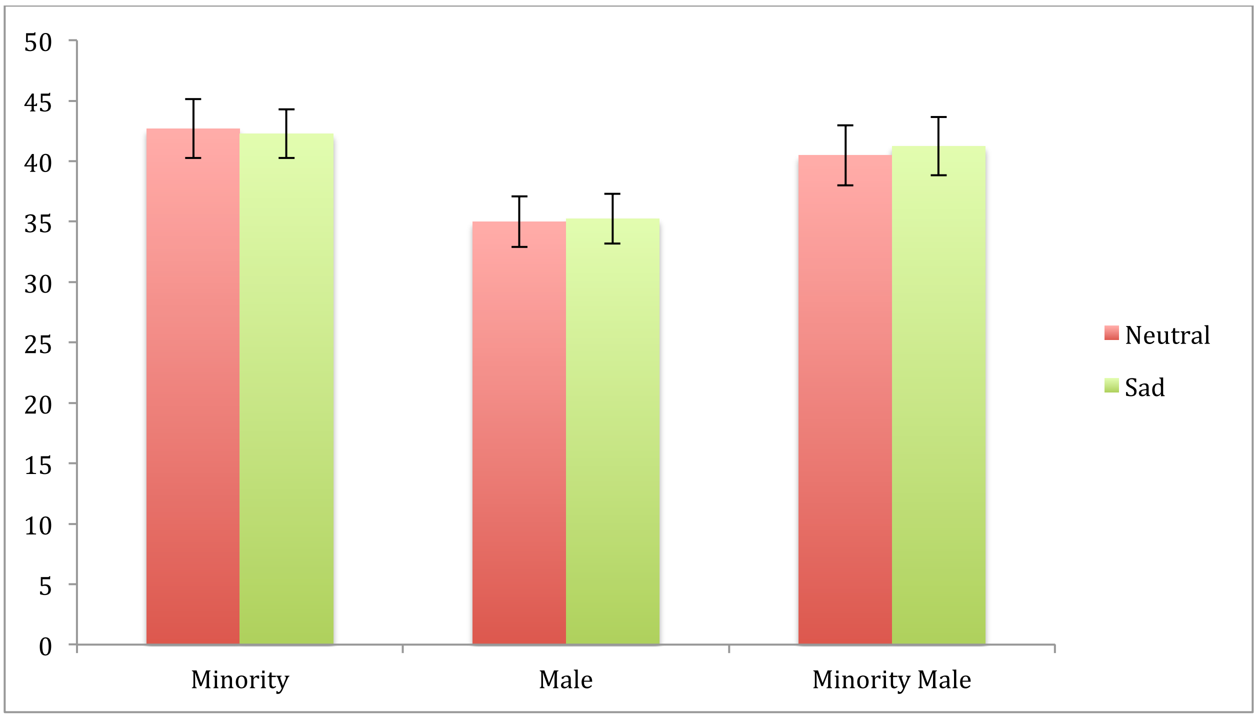

Figure 6. Minority male conjunction probability estimates and minority and male marginal probability estimates by mood prime.

Figure 7 also indicates a possibility of a significant difference of the probability judgments of white females in the sad verses neutral condition. Participants in the sad mood condition (M=27.1875) judged white females as having a higher probability of experiencing a negative education outcome than participants in the neutral mood condition (M = 22.5625). Their 99.60% confidence intervals, respectively, [22.0927, 32.2823] and [16.7615, 28.3635] overlap (see Table 2 and Table 1). A *t*-test was run to further test significance. The test determined the differed to be not quite statistically significant ($t(158) = 1.83$, $p = 0.0697$).

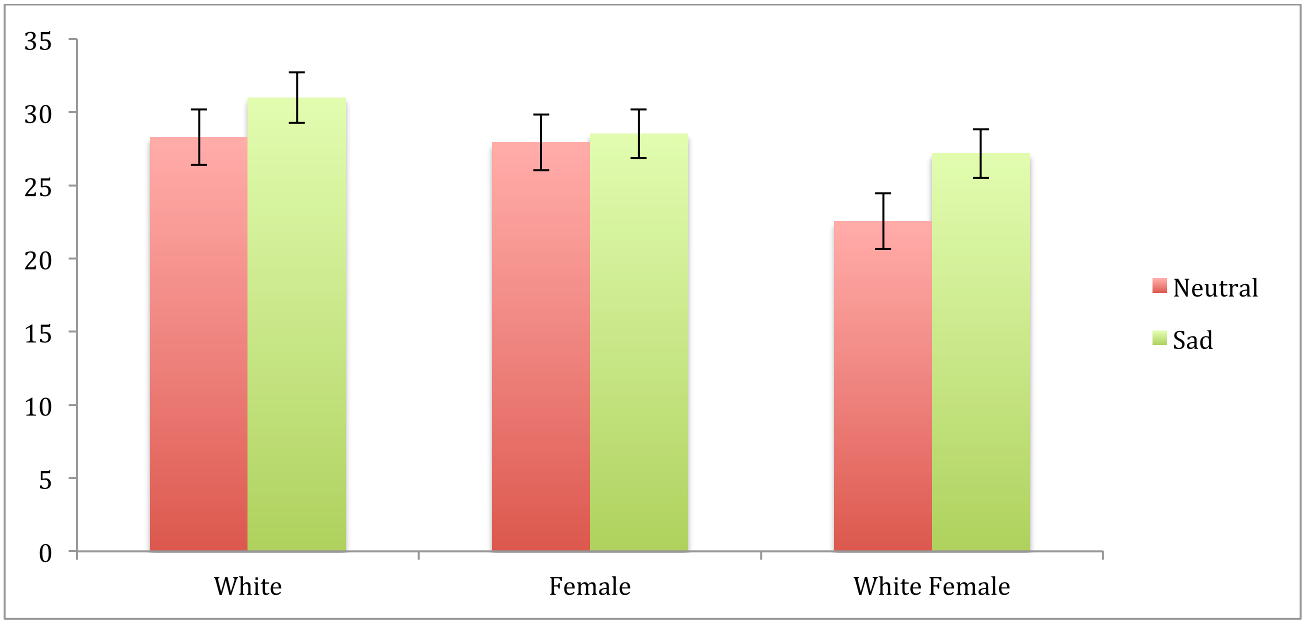

Figure 7. White female conjunction probability estimates and white and female marginal probability estimates by mood prime.

Discussion

Results did not show less stereotype-use in sad mood condition verses the neutral mood condition as hypothesized. However, it is clear participants in both mood conditions commit the conjunction fallacy differently between mood conditions and within moods for the stereotyped group in education (minorities). Participants under the sad mood committed the judgment error of minority females. Results were close to significant for participants under the sad condition making judgments on minority males. Mood differences between the sad and neutral conditions were also close to significance when judgments were made about minority females and white females.

Overall, negative mood increased the magnitude of judgments of the probability of adverse educational outcomes given by participants. It can be speculated that this is because participants make a similarity comparison between their negative mood state and the negative education outcomes being questioned. In addition, a negative induced mood state could potentially make participants frame their probability judgments in a negative way. This could be due to the fact that a majority of the participants were white and thus were optimistic about the outcomes for whites. Increases were greater in the conjunctions that involved whites or females. This excludes minority males, which are the group most negatively stereotyped in education.

Probability judgments for males, minorities, and minority males did not differ between mood states. This could be because minority males are the most stereotyped group in education, and consequently the judgments given in the neutral condition were already at the limit of the range of probabilities. It should also be noted that probability judgments for females did not shift between mood states either. Reasoning for this should be explored in new research.

The quantum explanation does not explain the effect of mood upon probability judgments. There is currently no mechanism in that theoretical framework for why some of the probabilities changed more between mood conditions while others did not. Marginal probabilities were overestimated. This can be represented in a quantum-like, vector representation. Participants might picture the probability question with the basis vectors not as orthogonal because they might not have a judgment. This unknown is represented with the basis vectors forming a smaller angle between each other. This in turn will make the belief state projection onto each of the basis vectors larger, and thus the probability judgment larger. Therefore, the differences in conjunction-probability judgments based on mood are better explained by the stereotype-use hypothesis. This is because people's judgments differed between demographics depending on their mood state.

Recent work on stereotypes and cognition has looked at stereotype-threat. Stereotypes simplify thinking by characterizing different groups. However, stereotypes only focus on a few traits to characterize a group. Furthermore, these are only a couple of the group's traits, and they are often overemphasized and a misrepresentation of the group. Negative stereotypes only focus on negative traits and do not take into consideration positive traits of a group. These negative traits are usually also prevalent in other groups, including the majority population. Even when traits are true for some of the group's population, stereotypes do not include the cause of such traits. Consequently, stereotypes of a group appear to be inherent and unchangeable, when in fact their origins are systematic (Simpson & Yinger, 1972).

Stereotype-use has well-documented effects on cognition. One area of study is the effect of stereotypes on targets. Targets sometimes succumb to the stereotype-threat. Stereotype threat occurs when an individual determines whether others are negatively stereotyping them because of a negative stereotype of a group they belong to. The target feels threatened, and uses cognitive energy to reduce the threat and determine if they are being stereotyped. This energy could instead be used for the task at hand (Schmader & Johns, 2003; Steele, Spencer, & Aronson, 2002).

In order for a target to be affected by stereotype threat, they must have to identify with the domain. Part of their identity has to be evaluated based on performance in the specific domain. The individual would not care about being stereotyped, or at least care less, if they did not strongly identify with the domain.

The stereotype threat is situational. The threat is not always there, and is triggered when the individual is aware that they can be evaluated by the negative stereotype. They become aware of the threat through situational cues. When the social situation is altered, the social cues of the possibility of being stereotyped are also changed. If the cues indicate a negative stereotype, then the target feels threatened, uses cognitive energy, and negatively performs. Research that manipulated the situation of the target demonstrated that the situational cues are key (McKay, Doverspike, Bowen-Hilton, & Martin, 2002).

According to Steele (1997), stereotype threat has five features. First, stereotype threat can hinder a person belonging to any group with a negative stereotype. For instance, white American males' scores on a math assessment were lower when they were told that their scores were compared to Asian American males (Aronson et al., 1999). Even though white males are not often not thought of as a stigmatized group, they still can be affected by stereotype-threat if framed in the right situation.

The second important characteristic of stereotype threat is that the negative stereotype about an individual's group has to be an important part of that person's identity in a related situation. The key is the threat of succumbing to the negative stereotype. Surrounding oneself with people who are not stereotyped, may make the stereotype more obvious. But that will not cause stereotype threat. One needs to strongly identify with the domain in question in order for their performance to suffer from stereotype threat. For example, women have been known to do poorly on a math test because of stereotype threat (Steele, 1997). This can occur whether they are alone taking a test, or in a classroom with men (who are not considered to be negatively stereotyped in that domain). The main requirement is that they have to strongly identify as a student and use their academic success to evaluate this. Women who become concerned that they will fit the stereotype that women are not good at math will do worse on the math exam. Thus, stereotype threat is very dependent on the specific situation.

In addition, stereotype threat varies widely in form and severity between groups and within groups in different situations. This is because the stereotype is not the same for all groups. They vary in meaning, degree, and the settings where they are applicable. The stereotype for Blacks and education is very different than the stereotype for white men and athletic performance (Steele, 1997). These are very different stereotypes for two distinct groups. Stereotypes for women in education vary in different situations. Women are affected by stereotype threat during their math class, but this is threat is diminished when they go to English class.

One does not even need to believe the stereotype or think that it describes themself for stereotype threat to occur. Steele (1997) gives the example of a black man waiting for a woman to take money out of an ATM. While waiting behind her, he thinks about how she could be scared that he will rob her. He wonders how he can remove any fear, but also understands that he cannot. She might not even be scared of him. The important part is that he had this thought process, even though he knew that he was not going to stereotypically rob her. But, he still felt the stereotype threat because he was worried that the woman would interpret his behavior to match the stereotype.

Lastly, an individual can overcome stereotype threat in one setting, but they can still be affected later in a new situation or the next challenge in that setting. For instance, female students might be able to overcome the gender-based stereotype of math performance in their early years of schooling. However, as she moves onto more advanced math classes, there are less and less female students, adding to the stereotype. Just because she was able to perform well before, does not dispel any future threat.

The present research examines stereotypes in education, although about a different aspect of cognition. Research has demonstrated that stereotype-threat has affected Latinos (Gonzales, Blanton, & Williams, 2002; Schmader &Johns, 2003), Blacks (Steele & Aronson, 1995), and women (Steele, 1997). The implications of this are grave, especially if the consequences of stereotype-threat occur in a school setting. Because students can succumb to stereotype-threat in a school setting, they must identify strongly with school. However, after poor performance, they may stop identifying with school, and stop excelling. This is detrimental not only for their school performance, but also future life outcomes.

While the current study did not directly address stereotype threat, it did provide evidence that stereotype use has measurable influence on social cognition. Future studies may use experimental manipulations to see if stereotype threat has an impact on the use of stereotype use in probability judgments in the social cognition domain.

Other limitations that could be considered for future studies include small sample size, ambiguity of questions, and limited mood manipulations. The small sample size led to a wide standard deviation in judgments, and thus made the criteria for statistically significance more stringent. Another limitation to the study was the ambiguity of the adverse education outcome questions. Questions were posed as negatives, which confused some participants. Future studies should change the mood manipulations. The mood manipulation should be longer in duration since current study's mood manipulation was brief. Also, future studies can also look at happy mood conditions, since only negative and neutral conditions were examined.

Conclusion

Mood did not have large effect on judgments. Past studies have shown that mood does have an effect on processing and affect the way we use stereotypes. The current research showed some evidence of this, even though it was in an unexpected direction. People's mood affected the extent to which people used stereotypes, however, negative mood did not increase deliberative processing as expected. To the contrary, individuals in negative mood states appeared to increase reliance on negative stereotypes when making probability judgments as compared to individuals in neutral mood states. Stereotype-use was demonstrated and the conjunction fallacy was committed. Conjunction fallacies can be modeled in classical probability and quantum probability. While it may be speculated that mood could influence vector states in the quantum model, the present results are more consistent with the stereotype-use explanation of the conjunction fallacy.

References

Aerts, D., & Aerts, S. (1995). Applications of quantum statistics in psychological studies of decision processes. *Foundations of Science, 1*, doi: 10.1007/978-94-015-8816-4_11

Aronson, J., Lustina, M., Good, C., Keough, K., Steele, C., & Brown, J. (1999). When white men can't do math: Necessary and sufficient factors in stereotype threat. *Journal of Experimental Social Psychology. 35*(1). 29-46.

Bar-Hillel, M., & Neter, E. (1993). How Alike Is It Versus How Likely Is It: A Disjunction Fallacy in Probability Judgments. *Journal of Personality and Social Psychology*, *65*(6), 1119-1131.

Barch, D. H., Jr., Schultz, J., Chechile, R.A., Sommers, S.R. (2013) *Perceptual priming reduces conjunction errors: Probabilistic reasoning with social and nonsocial stimuli*. Paper presented at the 2012 Convention of the Eastern Psychological Association, Pittsburgh, PA.

Bless H., Clore G. L., Schwarz N., Golisano V., Rabe C., Wölk M. (1996) Mood and the use of scripts: Does a happy mood really lead to mindlessness? *Journal of Personality and Social Psychology, 71*(4)*,* 665–679.

Bless, H., Schwarz, N., & Wieland, R. (1996). Mood and stereotyping: The impact of category and individuating information. *European Journal of Social Psychology, 26*(6)*,* 935-959.

Bodenhausen, G.V. (1990). Stereotypes as Judgmental Heuristics: Evidence of Circadian Variations in Discrimination. *Psychological Science, 1*(5)*,* 319-322.

Bodenhausen, G. V., Kramer, G. P., & Süsser, K. (1994). Happiness and stereotypic thinking in social judgment. *Journal of Personality and Social Psychology*, *66*(4), 621-632.

Bodenhausen, G. V., Sheppard, L. A., & Kramer, G. P. (1994). Negative affect and social judgment: The differential impact of anger and sadness. *European Journal of Social Psychology, 24*(1), 45-62.

Busemeyer, J. R., Pothos, E. M., Franco, R., & Trueblood, J. S. (2011). A quantum theoretical explanation for probability judgment errors. *Psychological Review*, *118*(2), 193-218.

Chann, Y. M. N. (2005). *The effects of mood and judgmental heuristics on decision making under uncertainty*. Unpublished manuscript, Department of Psychology, The University of New South Wales, Kensington, Australia.

Dirac, P. A. M. "principles of quantum mechanics." (1930).

von Neumann, J. (1932). Mathematical foundations of quantum mechanics (R. T. Beyer, Trans.). Princeton, NJ: Princeton University Press.

E-Prime (Version) [Computer software]. Sharpsburg, PA: Psychology Software Tools, Inc.

Edwards, J. A., & Weary, G. (1993). Depression and the impression-formation continuum: Piecemeal processing despite the availability of category information. *Journal of Personality and Social Psychology, 64*(4)*,* 636-645.

Erber, R., & Fiske, S.T. (1984). Outcome dependency and attention to inconsistent information. *Journal of Personality and Social Psychology, 47*(4)*,* 709-726.

Fedorikhin, A., & Patrick, V. M. (2010). Postive mood and resistance to temptation: The interfering influence of elevated arousal. *Journal of Consumer Research, 37*(4). 698-711.

Frederickson, B.L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition and Emotion, 19*(3), 313-332.

Gigerenzer, G., & Goldstein, D. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review, 103*, 650–669. doi:10.1037/0033-295X.103.4.650

Gonzales, P.M., Blanton, H., Williams, K.J. (2002). The effects of stereotype threat and double-minority status on the test performance of Latino women. *Personality & Social Psychology Bulletin*, *28*(5), 659-670.

Greenhut, R., (Producer), Allen W., (Director). (1986). Hannah and Her Sisters [Motion picture]. Los Angeles, CA: Orion Pictures

Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. *Cognition and Emotion, 9*(1), 87-108.

Hertwig, R., Benz, B., Krauss, S. (2008). The conjunction fallacy and many meanings of and. *Cognition, 108*(3)*,* 740-753.

Hertwig, R., & Gigerenzer, G. (1999). The 'conjunction fallacy' revisited: How intelligent inferences look like reasoning errors. *Journal of Behavioral Decision Making, 12*(4), 275-306.

Houston, A. I., & Wiesner, K. (2013). *Is quantum probability rational?* [Peer commentary on the paper "Can quantum probability provide a new direction for cognitive modeling?" by E.M. Pothos & J.R. Busemeyer]. doi:10.1017/S0140525X12002993

Johnson, E. J., Haubl, G. & Keinan, A. (2007). Aspects of endowment: A query theory of value construction. *Journal of Experimental Psychology: Learning, Memory and Cognition, 33*(3), 461–73.

Kahneman, D. (2012). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

Kolmogorov, A. N. (1933). Foundations of the theory of probability: New York, NY: Chelsea.

Lovell D., (Producer), Zeffirelli F., (Director). (1979). The Champ [Motion picture]. Culver City, CA: MGM/Pathe Home Video.

McKay, P.F., Doverspike, D., Bowen-Hilton, D., & Martin, Q.D. (2002). Stereotype threat effects on the Raven Advanced Progressive Matrices scores of African-Americans. *Journal of Applied Social Psychology, 32*(4), 767-787.

Michaels L., (Producer), Segal P., (Director). (1995). Tommy Boy [Motion picture]. Los Angeles, CA: Paramount Pictures

Morier, D. M., & Borgida, E. (1984). The Conjunction Fallacy A Task Specific Phenomenon?. *Personality and Social Psychology Bulletin, 10*(2), 243-252.

Nelson, S. K., & Schiffrin, H. H. (2009). Happy people don't follow the stereotype: The impact of mood on stereotyping. *Psi Chi Journal of Undergraduate Research, 14*(4)*,* 148-157

Neuberg, S.L., & Fiske, S.T. (1987). Motivational influences on impression formation: Outcome dependency, accuracy-driven attention, and individuating processes. *Journal of Personality and Social Psychology*, *53*(3), 431-444.

Park, J., & Banaji, M. R. (2000). Mood and heuristics: The influence of happy and sad states on sensitivity and bias in stereotyping. *Journal of Personality and Social Psychology, 78*(6), 1005–1023.

Pothos, E. M., & Busemeyer, J. R. (2013). Can quantum probability provide a new direction for cognitive modeling?. *Behavioral and Brain Sciences, 36*(3), 255-327.

Schmader, T., & Johns, M. (2003). Converging evidence that stereotype threat reduces working memory capacity. *Journal of Personality and Social Psychology*. *85*(3), 440-452.

Schwarz, N. (1990). Feelings as information: Informational and motivational functions of affective states. In E. T. Higgins & R. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (2, pp. 527-561). New York: Guilford Press.

Shafer, G., & Tversky, A. (1985). Languages and designs of probability judgment. *Cognitive Science*, *9*(3), 309-339.

Simpson, G.E., & Yinger, J.M., (1972) *Racial and cultural minorities: An analysis of prejudice and discrimination*. (4th ed.). New York, NY: Harper & Row.

Sinclair, R. C. (1988). Mood, categorization breadth, and performance appraisal: The effects of order of information acquisition and affective state on halo, accuracy, information retrieval, and evaluations. *Organizational Behavior and Human Decision Processes*, *42*(1), 22-46.

Steele, C.M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*(6), 613-629.

Steele, C.M. & Aronson, J. (1995). Stereotype threat and intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69* (5), 797-811.

Steele, C.M., Spencer, S.J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. In Zanna, M.P. (Ed), *Advances in experimental social psychology* (v 34, pp 379-440). San Diego, CA: Academic Press, Inc.

Tversky, A., & Kahneman, D. (1983) Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review*, *90*(4), 293-315.

Wason, P.C. (1960). On the failure to eliminate hypotheses in a conceptual task. *Quarterly Journal of Experimental Psychology, 12*(3), 129-140.

Wolford, G., Taylor, H. A., & Beck, J. R. (1990). The conjunction fallacy?. *Memory & Cognition, 18*(1), 47-53.