January 2015

SELECTION VERSUS REJECTION: THE ROLE OF TASK FRAMING IN DECISION MAKING

Jing Chen
Purdue University

Graduate School Form 30
Updated 1/15/2015

PURDUE UNIVERSITY
GRADUATE SCHOOL
Thesis/Dissertation Acceptance

This is to certify that the thesis/dissertation prepared

By Jing Chen

Entitled

Selection Versus Rejection: The Role of Task Framing on Decision Making

For the degree of Doctor of Philosophy

Is approved by the final examining committee:

Robert W. Proctor
Chair

Richard Schweickert

Steven J. Landry

Torsten O. Reimer

To the best of my knowledge and as understood by the student in the Thesis/Dissertation Agreement, Publication Delay, and Certification Disclaimer (Graduate School Form 32), this thesis/dissertation adheres to the provisions of Purdue University's "Policy of Integrity in Research" and the use of copyright material.

Approved by Major Professor(s): Robert W. Proctor

Approved by: Janice R. Kelly 7/8/2015

Head of the Departmental Graduate Program Date

SELECTION VERSUS REJECTION:

THE ROLE OF TASK FRAMING IN DECISION MAKING

A Dissertation

Submitted to the Faculty

of

Purdue University

by

Jing Chen

In Partial Fulfillment of the

Requirements for the Degree

of

Doctor of Philosophy

August 2015

Purdue University

West Lafayette, Indiana

ACKNOWLEDGEMENT

I would like to thank my major advisor, Dr. Robert W. Proctor, for his support and guidance in completing this dissertation research, and during my graduate studies. I would also like to thank Dr. Steven Landry, Dr. Mark Lehto, Dr. Torsten Reimer, and Dr. Richard Schweickert for their helpful comments regarding this project. Additionally, I would like to gratefully acknowledge Dr. Tahira Reid for making the eye tracker in her lab available to me during this project, and Youyi Bi, Ming Lou, Bin Hu, Qun Hui, Emily Riggins, and Victoria Robison for their assistance in conducting the experiments and/or analyzing the data. Finally, the greatest thanks are due to my husband, Bin, and my parents, who made it possible for me to complete this project, and special thanks to my son, Leonardo, for bringing the greatest happiness to my life.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

Appendix Figure Page

ABSTRACT

Chen, Jing. Ph.D., Purdue University, August 2015. Selection Versus Rejection: The Role of Task Framing in Decision Making. Major Professor: Robert W. Proctor.

Procedure invariance is a basic assumption of rational theories of choice, however, it has been shown to be violated: Different response modes, or task frames, sometimes reveal opposite preferences. This study focused on selection and rejection task frames, involving a unique type of problem with enriched and impoverished options, which has led to conflicting findings and theoretical explanations. On the one hand, greater preference has been found for the enriched option in the selection task than in the rejection task; this result is explained by a compatibility account, in which the positive features of the enriched option are more compatible with the selection task and the negative features with the rejection task (Shafir, 1993). On the other hand, it has been found that this preference difference in the two tasks interacts with the relative attractiveness of the two options: The enriched option is preferred more (less) often in the selection task than in the rejection task when it is more (less) attractiveness than the impoverished option; this finding is attributed to the accentuation of difference between options in the selection task, as stated in the accentuation account (Wedell, 1997).

My dissertation focused on examining the role of task frame in human decision making by distinguishing the compatibility and accentuation accounts, using an information-processing approach. Experiment 1 was conducted online on introductory psychology class students, with a plain statement for the task (either a selection or a rejection task). A large difference between the two task frames (i.e., the task framing effect) was found as predicted by the accentuation account. In Experiment 2, participants were recruited from the same subject pool but were required to verbalize their thoughts while performing the same tasks in a laboratory. No difference between the two task frames in the choice data was found in this experiment, possibly due to the need for verbalization of reasons in Experiment 2 or participants' confusion about the rejection task in Experiment 1. With a modified version of the questionnaire conducted on both MTurk workers (Experiment 3A) and introductory psychology students (Experiment 3B), Experiment 3 emphasized the tasks in several different ways to reduce the possible confusion regarding the task, and a similar pattern as in Experiment 1 was evident though with a smaller effect size. Thus, it was established that task confusion cannot explain the task framing effect alone.

Experiment 4 used a judgment task, in which participants were required to rate the likelihood of selecting or rejecting an option. It was again found that more participants in the negative task did not understand the task correctly before any feedback was provided. The ratings from this experiment were used as direct attractiveness measures, and a similar task framing effect was found with these measures. The finding of task framing effect was supported by the data from an eye-tracking experiment (Experiment 5), in which participants performed the tasks in the lab without being required to verbalize their thoughts. In the last two experiments, whether the task framing effect was influenced by time pressure was tested. Experiment 6 imposed time limits on participants and required them to respond within a short time, whereas Experiment 7 forced participants to wait a certain amount of time before they could respond. Both experiments found a task framing effect that did not differ from that in Experiment 3A, which indicates that this task framing effect was relatively automatic and that it did not take extra time for people to be more discriminating in the selection task than in the rejection task.

The current results are not consistent with the compatibility account, which predicts the enriched option always to be preferred more in the selection task. Instead, they are more consistent with the accentuation account, which predicts that the difference between the two task frames would interact with the relative attractiveness of the two options, with people being more discriminating under the selection task frame. Based on the current findings, a modified version of the accentuation account, explaining the difference between the two task frames in terms of availability of cognitive resources, was proposed. The modified accentuation account suggests that people are less discriminating in the rejection task because understanding the task per se is more effortful and occupies more cognitive resources.

INTRODUCTION

The principle of invariance (Tversky & Kahneman, 1986; Tversky, Sattath, & Slovic, 1988), which includes description invariance and procedure invariance (Shafir & Tversky, 1995; Slovic, 1995), is a basic assumption of rational theories of choice. Description and procedure invariance refer to the proposition that people's preferences should be consistent across different presentations of the options and methods of elicitation, respectively. These sub-principles of invariance have been shown to be violated in human decision making, the former in terms of information presentation and the latter in terms of response mode. For instance, the well-known framing effect (Tversky & Kahneman, 1981, 1986) violates description invariance, in which people's preferences are influenced by whether the same problem is presented in a positive or negative frame. The current study focused on violation of procedure invariance, in which different elicitation methods, or response modes, lead to predictably inconsistent preferences.

Preference Reversal

One robust phenomenon that violates procedure invariance is preference reversal. For example, when faced with two bets, one with large payoff but low probability (i.e., the $ bet) and the other with small payoff but high probability (i.e., the P bet), participants chose the P bet more often in a *choice* task but bid a higher price for the $ bet in a *pricing* task (Lichtenstein & Slovic, 1971, 1973; see also Slovic, 1995). Preference reversal has also been found between *attractiveness rating* and *pricing* tasks, with the P bet given higher rating in attractiveness but $ bet stated a higher price (e.g., Rubaltelli, Dickert, & Slovic, 2012; Schkade & Johnson, 1989). These distinct tasks involve different information-processing patterns and decision strategies.

Preference reversal has been established for other problems besides the gambles. Tversky et al. (1988) found that participants showed inconsistent preferences when performing *choice* versus *matching* tasks. In one of their problems, participants were to choose between two candidates for a position of production engineer. The scores on technical knowledge and human relations were provided for both candidates. Participants were told that the technical-knowledge attribute was more important than the human-relations attribute. One group of participants was given the two scores of each candidate and was to make a choice between the two candidates (i.e., the choice task); the other group was given three of the total four scores and was to generate the missing score to match the two candidates for the job (i.e., the matching task). In the choice task, the chosen candidate was the preferred one; in the matching task, a generated score lower than the missing value implied a preference for the candidate with the missing value. Tversky et al. found that in the choice task 65% of the participants indicated preference for the candidate with a higher score on technical knowledge, whereas in the matching task only 34% did so. This choice-matching discrepancy (also known as the prominence effect) suggests that the more important attribute looms larger in choice than in matching, and that the weightings of the attributes depend on the response mode. Tversky et al. proposed a contingent-weighting model to explain this finding, in which the trade-offs among attributes are contingent on the nature of the response, and "the weighting of inputs is enhanced by their compatibility with the output" (p. 371).

The Compatibility Principle

The compatibility effect is well known in the human performance literature: Performance is better when the stimulus is compatible with the response than when it is not (Kornblum, Hasbroucq, & Osman, 1990; Proctor & Reeve, 1990). For example, when responding to the location of a circle presented on a monitor, responses in the same relative location as the stimuli (e.g., a left keypress to a left circle) are faster and more accurate than those in the opposite relative location. This finding is called spatial stimulus-response compatibility (SRC) effect, which has been investigated widely (e.g., Fitts & Deininger, 1954; Proctor & Vu, 2006). More generally, Kornblum et al. (1990) proposed the idea of dimensional overlap for the SRC effect, which is defined as the degree to which attributes in stimuli and responses are "perceptually, structurally, or conceptually" similar. For example, a stimulus set of left and right locations has dimensional overlap (or similarity) with a response set of left and right keypresses, as well as a stimulus set of "left" and "right" words with that response set.

Starting from Tversky et al. (1988), the concept of compatibility has been brought into the field of human decision making. A similar effect of compatibility between stimulus attributes and response mode, or task nature, has also been studied in human decision making, though not as extensively as in the field of human performance. Similar to the dimensional overlap model (Kornblum et al., 1990), Slovic, Griffin, and Tversky (1990) concluded that the features that could enhance the compatibility between stimuli and responses include "the use of the same units (e.g., grades, ranks), the direction of relations (e.g., whether the correlations between input and output variables are positive or negative), and the numerical correspondence (e.g., similarity) between the values of input and output variables" (p. 23). The rationale for the compatibility effect is that the characteristics of the output tend to put more weights on the most compatible features of the input, and incompatibility requires additional efforts in mental transformation. Thus, the influence of response modes on the decision maker's preference is explained in terms of their compatibility with stimulus attributes.

Slovic et al. (1990) tested the compatibility effect with several experiments. In one experiment, participants were provided with both market value (in billions of dollars) and rank in market value of companies in a previous year, and were to predict each company's market value or rank in the next year. Consistent with the compatibility principle, participants who were required to predict market value weighted market value more than rank, and those who were to predict the rank weighted rank more than market value. In another experiment of Slovic et al., participants were asked to predict some students' performance in a history course, based on those students' letter grade and class rank in two other courses, respectively. For participants who made the prediction in terms of letter grade, the course presented in letter grade was weighted more than that in class rank, and the opposite was true for participants who made the prediction in terms of class rank.

The compatibility principle also explains preference reversals in experimental settings such as in c*omparison* versus *evaluation* tasks and corresponding features (Dhar & Nowlis, 2004; Nowlis & Simonson, 1997). Nowlis and Simonson proposed that people's preferences are affected by whether the task is to compare between the alternatives or to evaluate the alternatives individually. Specifically, "comparable" attributes such as price are more compatible with comparison tasks (e.g., choice), whereas "enriched" attributes such as brand name are more compatible with separate evaluation tasks (e.g., purchase likelihood rating), because the comparable attributes are easier to compare than the enriched attributes. In an example, there were two alternative televisions, TV A with lower price and low-quality brand ($209, Magnavox) and B with higher price and high-quality brand ($309, Sony). Participants were to choose between two televisions in a choice task and to rate their likelihood of purchase for each product in a rating task. Nowlis and Simonson found that TV A was preferred more often in the choice task than in the purchase likelihood rating task, whereas TV B was preferred more often in the rating than in the choice task.

In Nowlis and Simonson's (1997) study, similar preference reversals were also found with manipulations preserving the compatibility relation but the reversals disappeared when the compatibility relation was removed. The preference reversals were found for a low-quality brand product with an additional feature versus a high-quality brand product without that additional feature, and for a lower-price product with inferior country of origin versus a high-price product with superior country of origin, with the former alternatives in each pair being preferred more in choice than in ratings. The preference reversals also generalized to other types of comparison-based task (e.g., strength of preference ratings) and separate evaluation task (e.g., whether to purchase), and were eliminated when prices in dollars were replaced with price descriptions (e.g., "very high price"), or when brand names were replaced with numeric quality ratings. These results support the principle of compatibility that the weighting of an attribute is influenced by its compatibility with the preference elicitation task: Attributes that produce easy and clear comparisons are more compatible with comparison-based tasks, and less comparable attributes are more compatible with separate evaluation tasks.

Selection Versus Rejection Tasks

As reviewed above, besides the tasks of choice, pricing, rating, and matching (e.g., Lichtenstein & Slovic, 1971; Tversky et al., 1988), decision tasks have also been shown to influence decision-makers' preferences in terms of letter grade versus of class ranks (Slovic et al., 1990), and comparing alternatives versus evaluating alternatives individually (Dhar & Nowlis, 2004; Nowlis & Simonson, 1997). Among these tasks, one unique pair is selection versus rejection tasks, which are both choice tasks and are intuitively complementary (e.g., Lai & Hui, 2006; Meloy & Russo, 2004). People can choose from two options by selecting one (and implicitly eliminate the other) or rejecting one (and implicitly retain the other). However, studies have shown that these two tasks could reveal opposite preferences when the same alternatives are given.

The Compatibility Account

Selection and rejection tasks have been shown to be influential especially on problems involving attribute valence (e.g., good vs. bad). This influence has been explained in terms of the principle of compatibility (e.g., Shafir, 1993). The idea is that features are weighted more in a task that is compatible with them: Good features of an option have greater influence in a selection than in a rejection task, whereas bad features are more important in a rejection than in a selection task. The unevenly weighted features in decision process lead to different preferences under these tasks even with the same presentation of the options.

Nagpal and Krishnamurthy (2008) used the compatibility account to explain the difficulty in making a decision between two *unattractive* alternatives compared to that between two *attractive* alternatives. They proposed that the incompatibility between the unattractiveness and the selection task leads to greater decision difficulty and longer decision time. The compatibility is between the attribute valence and the nature of the task, that attractive alternatives are more compatible with a selection task (i.e., "I will choose option: A/B"), and unattractive alternatives are more compatible with a rejection task (i.e., "I will reject option: A/B"). The selection task requires a relative attractiveness judgment, which is incompatible with unattractiveness and leads to difficulty in decision making. To resolve this incompatibility, the authors used tasks of *selecting* as well as *rejecting* one of two options. Decision time, difficulty, effort, and motivation were examined as a function of compatibility. In the selection task, decisions were faster, easier, less effortful, and required less processing motivation for attractive than for unattractive alternatives, and the reverse was found in the rejection task.

In addition, Nagpal and Krishnamurthy's (2008) Experiment 2 framed the same option attributes positively (e.g., "The tint successfully blocks 80% of harmful rays from the sun") or negatively (e.g., "The tint fails to block 20% of harmful rays from the sun"), to make them attractive or unattractive, respectively. Similar results were found with this manipulation. Although Nagpal and Krishnamurthy's study did not focus on the choice per se, in a later study Krishnamurthy and Nagpal (2010) found the influence of incompatibility on decision makers' choices when options are presented sequentially. The assumption was that incompatibility resulted in effortful processing, which causes overweighting of the attributes. Thus, incompatibility induced preference *for* the option when the attributes were positive in a rejection task, and *against* the option when the attributes were negative in a selection task.

Compatibility can also be elicited by manipulating participants' goal orientation and the nature of the decision task. Chernev (2009) generated a promotion-focus (or prevention-focus) goal orientation by instructing participants to write an essay about hopes / aspirations (or duties / obligations). One difference between the promotion and prevention foci is that the former involves a concern with positive outcomes and the latter with negative outcomes. Thus, promotion focus is more compatible with the selection task and prevention focus is more compatible with the rejection task. Participants were to select or give up one of two options, or to decide by tossing a coin. The measurement used was decision confidence, obtained by a subjective rating on a 10-point scale, and also indicated by the frequency of tossing a coin in each condition. Promotion-focused individuals were found to be more confident in the selection task than in the rejection task, and the reverse was true for the prevention-focused individuals.

Unlike the above studies involving *options* that are overall attractive or unattractive, some earlier studies focused on the *features* that compose the options being positive or negative, and found more interesting and puzzling results: When paired with an option containing average features, an option containing both more positive and more negative features can be preferred to different degrees in a selection task than in a rejection task.

Shafir (1993) examined compatibility between positive and negative features of alternatives and the decision task frames (selection and rejection), and proposed that positive features are weighted more in the selection task and negative features of the options are weighted more in the rejection task. Two types of options were constructed and used, the enriched and the impoverished options. The enriched option had more positive as well as more negative features than the impoverished one. Shafir found that for a selection task in which participants needed to award or indicate a preference for one of the options, the enriched option was preferred more than for a rejection task in which participants were to deny or give up one of the options.

As an example, Shafir (1993) included a problem of an only-child sole-custody case, for which participants were supposed to serve on the jury to decide to *award* or *deny* sole custody of the child to which parent:

> Imagine that you serve on the jury of an only-child sole-custody case following a relatively messy divorce. The facts of the case are complicated by ambiguous economic, social, and emotional considerations, and you decide to base your decision entirely on the following few observations. [To which parent would you award sole custody of the child? / Which parent would you deny sole custody of the child?]

Parent A	average income
	average health
	average working hours
	reasonable rapport with the child
	relatively stable social life
Parent B	above-average income
	very close relationship with the child
	extremely active social life
	lots of work-related travel
	minor health problems (p. 549)

In this example, Parent B (the enriched option) had more positive as well as more negative features than Parent A (the impoverished option). If procedure invariance holds, the percentages of each parent being selected and rejected should sum to 100. However, Shafir found that when deciding which parent to award sole custody, Parent A was chosen (i.e., selected) by 36% of the participants, and Parent B 64%; when deciding which parent to deny sole custody, Parent A was chosen (i.e., rejected) by 45% of the participants, and Parent B 55%. The enriched option Parent B was preferred by 64% of the participants in the selection task but was preferred by 45% of the participants in the rejection task. The results were consistent with the concept of compatibility. The positive features were more compatible with the selection task because people seek "good" reasons to select an option, whereas the negative features were more compatible with the rejection task because people seek "bad" reasons to reject an option. Thus, the enriched option, which contained more positive as well as more negative features, was preferred more often in the selection task than in the rejection task.

The Accentuation Account

In the following years, Ganzach (1995) and Wedell (1997) followed up Shafir's (1993) study, providing different evidence and alternative accounts. Ganzach proposed that people have higher commitment in the selection task than in the rejection task because "one has to live with the alternative he accepts, but not with the alternative he rejects" (p. 115). With a higher commitment level, people tend to be more critical and focus more on the negative attributes of the options. Ganzach's Experiment 2 included a filler option, which was clearly not the intended answer and thus can be ignored in the current discussion, in addition to two experimental options similar to the enriched and impoverished options in Shafir's study. Participants were required to select or reject a job candidate out of each triplet. Contradictory with Shafir's results, Ganzach found that the enriched options were preferred more in the rejection task than in the selection task (see also Carlson & Bond, 2006).

Wedell (1997) proposed an accentuation account to explain both data sets from Shafir's (1993) and Ganzach's (1995) studies. Wedell noted that the overall attractiveness of the enriched options was generally higher than the impoverished options in Shafir's study, and the opposite was true in Ganzach's study (See Figure 1). According to the accentuation account, people are more discriminating and differences between alternatives are accentuated more in the selection task than in the rejection task. This difference is due to the assumptions that (1) there is greater commitment or need for justification in the selection task than in the rejection task and (2) justification requires discriminating and accentuating the differences between the options. Thus, when the overall attractiveness of one option is greater than that of the other option, participants' preferences for the more attractive option will be higher in the selection task than in the rejection task.

Wedell (1997) first analyzed the data from Shafir (1993) and Ganzach (1995), by plotting the "proportion preferring enriched" against the "overall proportion preferring enriched" to show the relation between them in the selection and rejection tasks separately. The "proportion preferring enriched" refers to the percentage the enriched option being selected in the selection task or it *not* being rejected in the rejection task, whereas the "overall proportion preferring enriched" refers to the average of the above two values and serves as a measure for the relative attractiveness of the enriched option. The combined data set showed a deeper slope for the selection-task line compared to the rejection-task line, meaning the selection task was affected by the relative attractiveness of options more than was the rejection task.

Wedell (1997) then conducted two experiments to verify the accentuation account directly. In his Experiment 1, which was with a similar design as the current study, 26 preference problems similar to those used by Shafir (1993) were presented to participants in either the selection or rejection frame. The problems were constructed so that the overall proportion of the enriched option being preferred was spreading from 30% to 70%. These new data showed the same pattern as the combined data from the previous two studies, in which the data pattern were similar to Shafir's results when the enriched option was more attractive and consistent with Ganzach's (1995) results when the impoverished option was more attractive. These results were consistent with the accentuation model that people are more discriminating in the selection than in the rejection task: Compared with the rejection task, people in the selection task prefer the more attractive option more often and the less attractive option less often.

Information-Processing Approach

The information-processing approach has been proposed to "focus on the processes of judgment and choice and use various methods to trace decision processing" (Payne & Bettman, 2004, p. 111; see also Glaholt & Reingold, 2011). These process-tracing methods include but are not limited to: Verbal protocols (e.g., Meloy & Russo, 2004; Nowlis & Simonson, 1997; Payne, 1976), monitoring of information search (e.g., eye-movement tracking; Rubaltelli et al., 2012; computerized information retrieval systems; Edwards & Fasolo, 2001), and response times (e.g., Bettman, Johnson, & Payne, 1990; Nagpal & Krishnamurthy, 2008). These methods emphasize *how* the decisions are made rather than just *what* the final decisions are.

Verbal Protocols

Verbal protocols are self-reports of participants' on-going decision-making processes, although they may influence the processes (Brand, Reimer, & Opwis, 2003; Hertzum & Holmegaard, 2015). Verbal protocols can provide the level of details and insights that are not provided by eye-tracking and other types of process markers (Payne, Braunstein, & Carroll, 1978; Russo, Johnson, & Stephens, 1989). Two common types of verbal protocol methods are concurrent protocols (while preforming the task) and retrospective protocols (upon completion of the task). Both methods have advantages and disadvantages (Kuusela & Pallab, 2000; Peute, de Keizer, & Jaspers, 2015; Whyte, Cormier, & Pickett-Hauber, 2010)): Concurrent protocols may alter the accuracy of the tasks (Hertzum & Holmegaard, 2015), whereas retrospective protocols could induce forgetting even with cues of the stimuli or responses (Russo et al., 1989) and result in evaluation of the task rather than recall of thoughts during the task (Gonzalez, 2003).

As an example for the use of verbal protocols in a study of task framing, Meloy and Russo (2004) used the concurrent verbal protocol method in examining the compatibility between decision frame (selection or rejection) and the valence of the alternatives (positive or negative). They created alternatives composed of only positive or negative features, so that selecting between the two positive alternatives or rejecting between the two negative alternatives were compatible conditions, and selecting between negative alternatives and rejecting between positive alternatives were incompatible conditions. Meloy and Russo found that task reframing (e.g., transforming a selection task into a rejection task) revealed by the verbal protocol data occurred more often in the incompatible conditions than in the compatible conditions.

Eye-Movement Tracking

Eye-tracking data can be used to reveal the decision maker's information search processing, and are less intrusive than other process-tracing methods such as information boards and mouse-tracing methods (Glöckner & Herbold, 2011; Orquin & Loose, 2013; Scholz, von Helversen, & Rieskamp, 2015). Typical measures in the decision making studies are: Number of fixations as a measure of cognitive effort or amount of information search; mean fixation duration as a measure for processing depth or effort; number of fixations and total fixation as measures for level of attention;

sequence of fixations as a measure of processing or information search pattern (Glöckner & Herbold, 2011; Kang & Landry, 2014; Rubaltelli et al., 2012; Venkatraman, Payne, & Huettel, 2014).

Regarding task framing, Rubaltelli et al.'s (2012) collected eye-tracking data from participants performing both an attractiveness rating task and a pricing task for different gambles problems. More fixations were found on the payoffs than on the associated probabilities in a pricing task, whereas the amount of fixations was similar on both the payoffs and the probabilities in an attractiveness-rating task. This result pattern is consistent with the assumption that the pricing task is more compatible with the payoffs of the options and the rating task is more compatible with the probabilities. Kuo et al. (2009) explored how the level of cognitive effort involved in decisions was influenced by positive and negative framing. Note that the framing was in terms of the information framing of the question (e.g., 200 people will be saved vs. 400 people will die) rather than the task framing. Total time spent and number of eye fixations on each problem were used as measures of cognitive effort. These eye-movement measures showed that participants expended more effort on the problems under the negative framing than under the positive framing. The rationale was that the positive and negative framing elicited positive and negative emotion, respectively, which exert different levels of cognitive effort in information processing (i.e., more negative emotion leads to higher motivation).

Decision Time

"Response time can provide insights into the process of deliberation prior to making a decision" (Rubinstein, 2013). The response time approach has been used especially when different theories have identical predictions of the outcome (choice) data but predict different decision-making processes that lead to different response times (e.g., Bergert & Nosofsky, 2007; Glöckner, 2007). For example, Nagpal and Krishnamurthy (2008) used decision time as one of the dependent variables, and found that time of processing was affected by the compatibility between task frame and valence of options: Decisions for attractive options were faster than those for unattractive options in a selection task, and the reverse was true for a rejection task. They proposed that the incompatibility between the (un)attractiveness and the decision task leads to longer decision time.

Time and effort go hand in hand. Decision time has been used as a measure of decision effort (Bettman et al., 1990; Bettman & Zins, 1979; Hoyer, 1984). Hoyer studied consumers' behavior on relatively unimportant and repeated purchases, using an in-person observation method. The observer recorded the amount of time taken and number of within-brand and cross-brand comparisons made by the consumers before they bought a certain brand of laundry detergent. On average it took the consumers 13 s to make a purchase decision, and most of them only examined one or two products before their final purchase choice. Hoyer concluded that "the typical consumer is making an extremely quick decision with only a minimal degree of cognitive effort in the store environment" (p. 826).

Bettman et al. (1990) used decision times (i.e., latencies) and self-reported task difficulty as measures for the effort required when using different decision strategies. They proposed a model of effort using weighted elementary information processes (EIPs) for describing strategies. The proposed model provided good fits when decision times and self-reported effort were used as an indicator of effort, respectively, and the weighted EIPs model fit better especially on decision times. Time spent and the self-reported effort were not perfectly correlated, but decision time was a relatively preferred measure because people may not be able to subjectively report their cognitive effort accurately.

Influence of Time Pressure

In reality, people sometimes need to make decisions under time pressure. For example, a person may need to decide which stock(s) to buy or to sell in a timely manner (Nursimulu & Bossaerts, 2014). Decision making is sensitive to time pressure (Slovic, 1995; Suter & Hertwig, 2011). There is evidence that people may use different information-processing strategies, speed up the information processing with the same strategies (Ordóñez & Benson, 1997), or change the decision criterion (Diederich, 2003) under time pressure than when decision speed is not critical. For example, under time pressure, people may attend more to general category information about the problem (Maule, Hockey, & Bdzola, 2000) or concentrate on more important attributes and relevant information (Edland, 1993).

Finucane, Alhakami, Slovic, and Johnson (2000) retested a common finding that risk and benefit of an activity are inversely related in people’s mind despite the fact that they are positively related in the physical world. This finding was proposed to be due to the overall affective evaluation of the activity (see also Slovic, Peters, Finucane, & MacGregor, 2005). Participants were required to rate the risk and benefit of various targets either with or without time pressure. This negative correlation between perceived risk and benefit was found to become stronger when the participants were under time pressure. Finucane et al. concluded that time pressure reduced the analytic processes and increased the reliance on affective processes in this type of risk/benefit judgment.

Present Study

The seemingly conflicting finding that the same option is preferred to different degrees under the selection and rejection task frames is interesting because it is a violation of procedure invariance, which is a crucial component in theories of rational decision. The different result patterns and theoretical explanations provided by Shafir (1993) and Wedell (1997) deserve further examination. Note that both accounts emphasize the importance of the decision tasks, though in different manners. According to the compatibility account, the relation between the valence of features in the options and the nature of the tasks is the crucial factor that leads to changes in preference across the tasks, especially when the two options are otherwise comparable. According to the accentuation account, changes in preferences in the two tasks, which have different levels of need for justification, depend on the relative attractiveness of the two options, and the more (less) attractive option is preferred more (less) in the selection task because people have more commitment involved under this task frame.

Despite its significance, this discrepancy has been ignored in the decision-making literature, along with little attention being paid to the compatibility principle in the field. As of May 29, 2015, Shafir's (1993) study has been cited 152 times in PsycINFO, whereas Wedell's (1997) article, which proposed the conflict, has been cited only 15 times. Among the latter citations, only two articles discussed this discrepancy, one of which supported the compatibility account (Meloy & Russo, 2004) but the other of which suggested evidence in favor of the accentuation account (Colombo, Nicotra, & Marino, 2002). Rather than the actual choice made by participants, Meloy and Russo focused on the commitment to the chosen alternative (measured by a certainty rating on the final choice made), accentuation of attribute difference (measured by how much the evaluation of the alternatives deviate from the midpoint on a 9-point scale), and predecisional distortion of information (measured by comparing the ratings from the participants who were required to make a choice to those who did not need to make a choice). Colombo et al. used a small number of participants (34 or 36 participants in each condition) and only included problems in which the overall preference of the enriched option was lower than .50.

The present study was motivated by this issue to revisit the enriched-impoverished paradigm, with the aim of investigating how decision task frame influences preferences. The goal was to test the compatibility and accentuation accounts, and to propose an alternative account to explain the results if necessary. The compatibility account and accentuation account provide different insights into the role of task frame. The former suggests that selection and rejection tasks influence decision making by putting more weights on the features compatible with the task, and the latter proposes that people are discriminating in the selection task due to higher level of commitment. These different views were supported by data from Shafir (1993) and Wedell (1997), respectively. Thus, to understand how indeed the selection and rejection task frames function or which of the two accounts captures the role of task frame correctly, the result pattern in previous studies needs to be verified. In all the current experiments, there were 30 problems in total: the 26 problems used by Wedell, three of which were also used by Shafir, in addition to four new gamble problems that are similar to the gamble problems used by Shafir.

In general, the primary measures in the experiments include the choices participants made, the verbal protocols, and eye-movement data. In addition, response time, satisfaction level, and confidence level were also compared across the two task frames for the 30 problems. The comparison results can be informative for examining how task frames influence choices and information-search patterns, and which task frame is superior by saving more time, leading to more satisfaction, and/or yielding more confidence.

Experiment 1 was conducted online with the 30 problems on introductory psychology students through Sona (purdue-psych.sona-systems.com), and participants performed either a selection or rejection task on all the problems. Following each problem, participants were required to rate their satisfaction and confidence regarding the choice they just made. A pattern that was similar to Wedell's (1997) results predicted by the accentuation account was obtained: Participants were more discriminating in the selection than in the rejection task as indicated by a deeper regression line in the selection task.

Experiment 2 applied a verbal protocol method in a laboratory setting. Participants worked on the same 30 problems while being required to verbally report their thoughts during decision making. Surprisingly, the choice data showed no difference under the two task frames, possibly due to the need for verbalization of reasons for their choices or to the finding that more than half participants in the rejection task were confused about the task at the beginning of the experiment. The verbal-protocol data showed that participants in both tasks mentioned the positive features roughly the same, but the negative features were mentioned more in the rejection task than in the selection task, consistent with the compatibility account. The need for verbalization of the reasons promoted the strategy that fits with the compatibility account, which is a reason-based approach to understanding decisions (Shafir, Simonson, & Tversky, 1993).

The questionnaires in Experiment 3 were modified based on those used in Experiment 1 to make the task requirements clearer. This experiment was conducted on Sona as well as on Amazon Mechanical Turk (MTurk, www.mturk.com) to obtain data from different participant populations. The difference between the two task frames was smaller than that in Experiment 1, but was still evident. The results indicated that task confusion may have contributed to the non-task-framing effect in Experiment 2, but it was not the whole story. Thus, in Experiment 2 the need for verbalization of reasons reduced the difference in choice between the two task frames, and Experiment 3 confirmed the result pattern that supports the accentuation account.

Experiment 4 obtained the relative attractiveness of the two options in each problems directly by requiring participants to rate the likelihood they would select/reject an option. This relative attractiveness rating is highly correlated with the overall proportion preferring the options used in previous experiments. All data in previous experiments were reanalyzed with these new attractiveness ratings and similar result patterns were found.

Experiment 5 utilized the eye-tracking technique to collect participants' eye-movement patterns in a laboratory setting. The purpose was to evaluate how participants search information under different task frames, and to seek patterns that fit with one of the two accounts. Not much difference in the eye movements was found between the task frames, but a measure for cognitive effort (i.e., average fixation duration) showed more cognitive effort was involved in the rejection task than in the selection task. The choice data once again were consistent with the accentuation account, although the eye-movement data indicated that the difference between the two tasks was due to the rejection task being more effortful.

Experiments 6 and 7 included time constraints in an MTurk experiment similar to Experiment 3. Participants in Experiment 6 were required to respond within a time limit for each problem, and participants in Experiment 7 were not able to respond before a period of time. The result patterns in the last two experiments turned out to be similar to the pattern obtained in Experiment 3, which indicates that the accentuation process is relatively automatic.

EXPERIMENT 1. ONLINE CHOICE TASK ON SONA

The purpose of this experiment was to verify the result pattern of how task framing influences people's preferences, that is, to examine whether the result pattern of Wedell (1997; in support of the accentuation account) or Shafir (1993; in support of the compatibility account), or a new result pattern, was obtained in the current experiment setting. On the one hand, if the compatibility account explains the task framing effect, the enriched option will be preferred more often in the selection task (i.e., being selected) than in the rejection task (i.e., not being rejected), and this difference will not be influenced by the relative attractiveness of the two options. On the other hand, if the accentuation account holds, the more attractive option, regardless of whether it is enriched or impoverished, will be preferred more in the selection task than in the rejection task.

Method

Participants

Participants were 250 (99 female) Purdue University undergraduate students who participated for experimental credits in an introductory psychology course. The average age was 19.4 (± 1.1) years old.

Apparatus and Stimuli

The experimental task was composed of 30 binary-choice problems regarding different scenarios in daily life, such as choosing a restaurant, university, and daycare (see Appendix C). These problems were adapted from those used by Wedell (1997) and some by Shafir (1993). Each problem had two options, an enriched option and an impoverished option. The enriched option contained both very positive and very negative features, and the impoverished option contained similar, but more average features.

The problems were constructed and presented by Qualtrics (https://purdue.qualtrics.com). The order of the problems was randomly assigned to each participant. When presenting the problems, general information regarding the scenario and the decision task was presented on top of the page, and the two options were presented side-by-side below the general information. In this experiment, the enriched option was always presented to the left of the impoverished option. The features were presented in the same order in both options so that a feature in the enriched option was in the same line as that feature in the impoverished option. However, the order of the features within each option was counterbalanced across participants: In the enriched option the positive features were presented above the negative features for half of the participants, and the reversed feature order was used for the other half of the participants; in the impoverished option, the features were presented in the same order as those in the enriched option.

The decision task was either a selection or a rejection task, and participants were randomly assigned to one of the task frames. In the selection task, participants were to select the more favorable option, and in the rejection task the participants were to reject the less favorable option. The scenarios in the rejection tasks were similar to those in the selection tasks, but were worded to indicate that a "rejection" (e.g., return an extra computer) was needed.

Following each problem were two questions "How satisfied are you with the decision you just made?" and "How confident are you about the choice you just made?" The answers for both questions were 10-point, with 1 meaning "very dissatisfied" or "very unconfident", and 10 meaning "very satisfied" and "very confident".

Design and Procedure

Participants were given a link to the online questionnaire once they signed up for the experiment through an experiment registration system (Sona; purdue-psych.sona-systems.com), and they were randomly assigned to one of four between-subjects conditions based on a combination of feature order (positive-to-negative vs. negative-to-positive) and task frame (selection vs. rejection).

At the beginning of the experiment, participants were instructed to minimize the background noise or distraction in the environment and were told, "You will be presented with a number of problems, for each of which you need to choose an option. Please take as much time as you need." Each problem was presented on a single page, followed by a second page containing the satisfaction and confidence questions. Participants needed to click on a "next" button located on the right bottom of the page to proceed to the next page, and were not able to go back to the previous pages. The time to submit the first page of each problem (i.e., to complete the selection or rejection task) was recorded by Qualtrics, but participants were not informed of this timing recording, and they were allowed as much time as they needed to work on the problems. A statement "You have completed [x] of 30 questions" with [x] referring to the number of completed problems was shown below the "next" button. After completing all 30 problems, participants were instructed to send a randomly generated code to the experimenter by email in order to get the experimental credit.

Results

Outlier Trials

All participants were included in the following analyses. To improve the quality of the data, lower and upper cutoffs for response time (RT, i.e., time to complete each problem) were used. The lower cutoff for RT was determined based on the reading speed of an average adult (http://www.humanfactors.com/newsletters/human_interaction_speeds.asp), which is around 250 to 300 words per minute. For each problem, the assumption for the fastest possible speed was that the participants were reading with the fastest average speed of 300 words per minute, and were only reading the two options in the problem. For example, if a problem has x words in the problem title, y words in option A, and z words in option B, then the lower cutoff for this problem is $(y + z)/300*60$ seconds. Note that this cutoff is relatively conservative so that not too many data were excluded from the analyses. A higher cutoff was set arbitrarily at 500 ms, the purpose of which was to exclude occasional long trials. These two cutoffs excluded 24.1% of the total trials, which may be due to participants not paying enough attention to the task or submitting the page accidently. Mean and standard deviation of the remaining trials were calculated for each problem in the selection and rejection tasks separately, and an *M* ± *3SD* cutoff was used to further clean the data, which excluded additional 1.7% of the total trials.

Choice Data

The percentage of selecting or rejecting an option was then computed for each problem by averaging across the participants. The overall proportion of the enriched option being preferred was computed in the same way as in Wedell (1997, Experiment 1), by aggregating proportions of the enriched option being preferred in the selection and rejection tasks (i.e., the percentage of an enriched option being selected and that of the corresponding impoverished option being rejected).

The proportions preferring the enriched option in the selection and rejection tasks were plotted against the overall proportion of the enriched option being preferred to form two regression lines. An overlap between the two lines representing the selection and rejection tasks would indicate that there was no influence of the task frame. Otherwise, the compatibility account predicts the selection line to be higher than the rejection line and the two lines to be parallel; in contrast, the accentuation account predicts a crossover of the two lines, with the selection line having a steeper slope than the rejection line (see Figure 2).

The results showed a similar pattern (see Figure 3) to that predicted by the accentuation account. The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option for both the selection task, $F(1, 28) = 584.48$, $p < .001$, $R^2 = .977$, $R^2_{\text{Adjusted}} = .953$, and the rejection task, $F(1, 28) = 167.11$, $p < .001$, $R^2 = .925$, $R^2_{\text{Adjusted}} = .851$. The coefficients of the two regression functions were significant, for both the selection task, *Beta* = 1.304, $t(29) = 24.18$, $p < .001$, and the rejection task, *Beta* = 0.697, $t(29) = 12.93$, $p < .001$. The coefficients were 1.20 and 0.82 for the selection and reject tasks, respectively, for Wedell's (1997) data. More important, the difference between the two coefficients was also significant, $t(29) = 7.96$, $p < .001$.

Note that the two regression lines were not independent and the sum of the two regression coefficients was always 2. This dependence was because the overall proportion preferring the enriched option (i.e., the x axis) was an average of the values on the two lines representing the selection and rejection tasks. Later, in Experiment 4, a direct measure of the relative attractiveness of the enriched option was obtained and used as the x axis. Using this new measure made the two lines independent, yet the new regression lines looked similar to the original ones (see the bottom panels in Figures 2, 3, 9, 10, 11, 12, and 13).

Decision Time

The mean time to complete each problem, recorded as the time used to submit each page, was used for the timing analysis. A repeated-measures ANOVA was conducted on the decision time with task frame (selection vs. rejection), feature order (positive-negative vs. negative-positive) as within-subject variables. There were main effects of task frame (*M*s = 25.21 vs. 27.88 s for selection and rejection tasks, respectively), $F(1, 29) = 27.87$, $p < .001$, $\eta_p^2 = .49$, and feature order (*M*s = 25.00 vs. 28.08 s for the positive-negative and negative-positive feature orders, respectively), $F(1, 29) = 45.69$, $p < .001$, $\eta_p^2 = .61$, but no significant interaction between these two variables, $F(1, 29) = .02$, $p = .882$, $\eta_p^2 = .00$.

Subjective Ratings

Similar ANOVAs were conducted on the satisfaction and confidence ratings following each choice problem. Across all the experiments in the current study, the results regarding the effect of task frame on these subjective ratings were not consistent, so these data are put in Appendix D.

Discussion

First of all, the current experiment showed a difference in the selection and rejection tasks, confirming a task framing effect. It is straightforward, and shown by the positive slopes of both the selection and rejection lines in Figure 1, that the proportion of one option being preferred in either task should be positively correlated to the relative attractiveness of this option (indicated by the overall proportion of this option being preferred in both tasks). Yet, the option was preferred more in the selection than in the rejection task if it had high attractiveness, and preferred less in the selection than in the rejection task if it had a low attractiveness. In other words, the relative attractiveness had a more profound effect in the selection task than in the rejection task, that is, people are more discriminating in the selection task.

In binary-choice tasks, the selection and rejection tasks were logically complimentary, by which different framings of one problem should lead to the same preference of the decision maker. The current experiment violated this principle of procedure invariance. Moreover, the results in this experiment were consistent with the accentuation account proposed by Wedell (1997). The accentuation account claims that people have higher commitment level in the selection task than in the rejection task, and thus accentuate the difference more in the selection task. The accentuated differences are reflected by selecting the more attractive option more and the less attractive option less in the selection task.

In addition, the decision times were shorter in the selection task than those in the rejection task. In other words, the selection task frame took less time while people managed to be more discriminating. These results imply that the selection task frame may be a "superior" task frame for people to make decision. So if people have "real" preferences, those should be in line with the answers revealed under the selection task frame.

EXPERIMENT 2. IN-LAB CHOICE TASK WITH VERBAL PROTOCOLS

The purpose of Experiment 2 was to investigate how participants make a certain choice and what their information-processing patterns are under the selection and rejection tasks. Both the accentuation account and the compatibility account are aimed at explaining the underlying decision-making processes, yet Experiment 1 and previous studies (Ganzach, 1995; Shafir, 1993; Wedell, 1997) all focus on the decision outcomes under different task frames. Thus, more process-tracing data is needed to directly reveal the underlying processes that make a difference under the two task frames. Experiment 2 used the method of concurrent verbal protocols (or "think aloud"), which has been used to uncover people's thoughts while performing a certain task. To complement the outcome data from Experiment 1, this experiment was conducted in a laboratory setting to obtain detailed data on people's thoughts as to how and why they make the decisions.

Method

Participants

Forty-one (13 females; average age 19.7 ± 1.4) Purdue University undergraduate students participated for experimental credits in an introductory psychology course. These students did not participate in Experiment 1.

Apparatus and Stimuli

The apparatus and stimuli were similar to Experiment 1 except that participants were invited to the lab, and the experiment was conducted on a computer located in a quiet cubicle.

Design and Procedure

The design and procedure were similar to Experiment 1 except that the researcher sat in the cubicle next to the participant, and the participant was required to "think aloud" during the experiment. Participants were told, "Please speak out your thoughts while working on these problems. You will be reminded by the experimenter if you have kept silent for more than 30 s." This 30-s cutoff was adopted from the methods in Hertzum and Holmegaard (2015). They were also encouraged to focus on how and why they make the decisions. Participants' vocal responses were recorded with their permission. Half of the auditory recording of one participant was missing due to a failure of the recording device. All the remaining auditory recordings were transcribed by the researcher and two undergraduate research assistants. The transcripts were then coded separately by the same two undergraduate researchers, who were naive to the purpose of the study.

Results

All participants were included in the following analyses, except one who ignored the instruction and did not report verbally as required. Half of the remaining 40 participants performed the selection task, and the other half performed the rejection task.

Choice Data

The regression lines were plotted using the same method as in Experiment 1. The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option in both the selection task, $F(1, 28) = 83.52$, $p < .001$, $R^2 = .865$, $R^2_{\text{Adjusted}} = .740$, and the rejection task, $F(1, 28) = 77.00$, $p < .001$, $R^2 = .856$, $R^2_{\text{Adjusted}} = .724$. The coefficients of the two regression functions were significant, for both the selection task, *Beta* = 1.036, $t(29) = 9.14$, $p < .001$, and the rejection task, *Beta* = 1.002, $t(29) = 8.78$, $p < .001$. Different from Experiment 1, the difference between the two coefficients was not significant, $t(29) = .21$, $p = .834$. The lines for the selection and rejection tasks were almost overlapped entirely with each other (see Figure 4), indicating that there was no difference between the two task frames in terms of which choice participants made.

Decision Time

Treating each problem as an experimental unit, repeated-measure ANOVAs were conducted on decision time, satisfaction rating, and confidence rating, with task frame (selection vs. rejection) and feature order (positive-negative vs. negative-positive) as within-subject variables.

There were significant main effects of task frame (*M*s = 44.87 vs. 51.03 s for selection and rejection tasks, respectively), $F(1, 29) = 91.89$, $p < .001$, $\eta_p^2 = .76$, and feature order (*M*s = 49.05 and 46.85 s for positive-negative and negative-positive feature orders, respectively), $F(1, 29) = 6.33$, $p = .018$, $\eta_p^2 = .18$, and an interaction between them, $F(1, 29) = 10.77$, $p = .003$, $\eta_p^2 = .27$. The selection task took longer for the positive-negative feature order than for the negative-positive feature order (*M*s =

47.34 vs. 42.39 s), whereas the rejection task did not show a similar difference due to the feature order (*M*s = 50.77 vs. 51.30 s).

Participant-Based Verbal Protocol Data

The verbal protocol data were transcribed by the researcher and two undergraduate research assistants word-by-word. Then the two research assistants, who were naive to the purpose of this study, coded the transcripts for each problem and for each participant. For each problem, they generated four ratings for whether the participant mentioned (coded as 1) the positive or negative features of the enriched or impoverished option or not (coded as 0). The research assistants were instructed to code the data independently based on their own understanding of the transcripts. The ratings of the two assistants were highly correlated, Pearson's $r = .950$, $n = 160$, $p < .001$, and the average of the two sets of ratings were used in subsequent analyses.

For each participant, four data points were obtained by aggregating data across all problems and were used in the following analysis: the frequency of the positive/negative features mentioned in the enriched/impoverished options. A repeated-measure ANOVA was conducted with (positive vs. negative) feature and (enriched vs. impoverished) option as within-subject variables, and (selection vs. rejection) task as a between-subject variable. (Feature order did not have any significant effect and thus was not included as a factor in the analysis.) There were significant main effects of feature (*M*s = 15.8 vs. 10.8 for positive and negative features, respectively), $F(1, 38) = 96.12$, $p < .001$, $\eta_p^2 = .72$, and option type (*M*s = 16.6 vs. 10.0 for enriched and impoverished options, respectively), $F(1, 38) = 154.07$, $p < .001$, $\eta_p^2 = .80$. There were also significant interactions between feature and task (positive features were mentioned roughly equally for both the selection and rejection tasks, *M*s = 16.0 vs. 15.6, but negative features were mentioned more in the rejection task than in the selection task, *M*s = 11.8 vs. 9.5; see Figure 5 top), $F(1, 38) = 7.21$, $p = .011$, $\eta_p^2 = .16$, and between feature and option type (the difference between enriched and impoverished options was smaller for the positive features, *M*s = 18.1 vs. 13.5, than for the negative features, *M*s = 15.1 vs. 6.4; see Figure 6 top), $F(1, 38) = 11.37$, $p = .002$, $\eta_p^2 = .23$. No other effects were significant, *p*s > .110.

Problem-Based Verbal Protocol Data

Problem-based analysis showed a similar pattern except that the difference between the selection and rejection tasks was significant.

In this analysis, each problem was treated as an experimental unit. For each problem, eight data points were obtained by aggregating data across all participants and used in the following analysis: the frequency of the positive/negative features mentioned in the enriched/impoverished options for the selection/rejection tasks. A repeated-measure ANOVA was conducted with (positive vs. negative) feature, (enriched vs. impoverished) option, and (selection vs. rejection) task as variables. There were significant main effects of feature (*M*s = 10.5 vs. 7.2 for positive and negative features, respectively), $F(1, 29) = 180.32$, $p < .001$, $\eta_p^2 = .86$, option type (*M*s = 11.1 vs. 6.6 for enriched and impoverished options, respectively), $F(1, 29) = 67.42$, $p < .001$, $\eta_p^2 = .70$, and task (*M*s = 8.5 vs. 9.2 for selection and rejection tasks, respectively), $F(1, 29) = 11.76$, $p = .002$, $\eta_p^2 = .29$.

There were also significant interactions between feature and task (positive features were mentioned roughly equally for both the selection and rejection tasks, *M*s

= 10.6 vs. 10.4, but negative features were mentioned more in the rejection task than in the selection task, *M*s = 8.0 vs. 6.4; see Figure 5 bottom), $F(1, 29) = 23.15$, $p < .001$, $\eta_p^2 = .44$, and between feature and option (the difference between enriched and impoverished options was smaller for the positive features, *M*s = 12.0 vs. 9.0, than for the negative features, *M*s = 10.1 vs. 4.3; see Figure 6 bottom), $F(1, 29) = 5.23$, $p = .030$, $\eta_p^2 = .15$. No other effects were significant, *p*s > .139.

To compute how much the participants considered the features of the enriched option relative to the features of the impoverished option, the relative weights

$$\frac{Frequency\ (Positive\ or\ negative\ features\ in\ EO)}{Frequency\ (Positive\ or\ negative\ features\ in\ EO) + Frequency\ (Positive\ or\ negative\ features\ in\ IO)}$$

were used, where *EO* represents enriched option and *IO* represents impoverished option. The relative weights for positive/negative features in the selection and rejection tasks were plotted against the relative attractiveness of the enriched options obtained in Experiment 4 (see later). Figure 7 shows that the positive features seem to have a greater effect in the selection task (comparison between the solid vs. dashed black lines) and the negative features seem to have a greater effect in the rejection task (comparison between the solid vs. dashed red lines), but these differences were not statistically significant, *t*s < 1.

Discussion

In Experiment 2, participants were invited to the lab and to "think aloud" while they were performing the same task as participants in Experiment 1. The choice data from these participants showed no difference between the selection and rejection tasks

– people were equally discriminating under both task frames. The participants from both experiments were from the same participant pool, yet they showed very different result patterns in terms of the choice preferences. There are two possible reasons why the result pattern in this experiment differed from that in Experiment 1.

For one possible reason, the need for verbalization of reasons for decision-making leads participants to think more about the problems and make more rational decisions. When asked about their thoughts about the experiment at the end, one participant commented that "… speaking it out makes me think more". The verbal protocol method has been shown in some studies to enhance problem-solving performance (Brand et al., 2003), reduce the overestimation of time taken for a task (Hertzum & Holmegaard, 2015), and alter the accuracy in a simple addition and a gamble choice task (Russo et al., 1989). Although not directly tested on the verbal protocols method, some other types of process-tracing methods have been proposed to hinder automatic processing in decision making (Glöckner & Betsch, 2008). In two of Shafir's (1993) problems, participants were asked to provide justifications for their choice by writing down the reasons upon making their decision. He found a significant effect of the enriched option being selected and rejected more often than the impoverished option in one problem but not in the other one. The verbal protocols procedure used in Experiment 2 may have elicited more needs of justification than the written procedure. It is reasonable to speculate that people rely on more deliberative thinking and become more "rational" with the think-aloud task requirement.

The other possible reason is that a portion of the online participants in the rejection task may have misunderstood the task frame as a selection task for at least the first few questions. Note that more than half (12) of the 20 participants in the rejection condition of Experiment 2 understood the first question incorrectly by taking it as a selection task, until I reminded them that it was a rejection task. This reversal of the task frame was not eliminated in Experiment 1 and could have led to the results in the rejection task being neutralized, reflected by a flatter regression line in the rejection task. This speculation was also consistent with a previous finding by Shafir (1993), in which 59% of a group of participants reported paraphrasing the rejection question into the selection question, but only 14% reported paraphrasing the question in the opposite direction. Thus, it is reasonable to attribute the difference between the above two experiments to people being more easily confused by the rejection task especially when they are left alone to perform the tasks without proper feedback.

Regarding the selection and rejection tasks, participants in both tasks mentioned the positive features equally but the rejection task led participants to think about the negative features more, which is in line with the compatibility account. The compatibility account is a reason-based approach, which proposes that when making decision, people seek and construct reasons to justify their choices (Shafir et al., 1993). The verbal protocols in this experiment required participants to speak out their thoughts, especially how they make the choices. These requirements may have promoted the participants to adopt strategies (e.g., seeking good reasons to select one option and bad reasons to reject one option) that fit with the compatibility account.

To conclude, the different result patterns obtained in Experiments 1 and 2 may have been due to the online participants being more confused about the rejection task and/or the task requirements for verbalization of reasons imposed by the think-aloud method. In addition, the two theoretical explanations may not be mutually exclusive, but different strategies people could take under different task requirements.

EXPERIMENT 3. ONLINE CHOICE TASKS EMPHASIZING TASK FRAMES

One possible reason for the difference between Experiments 1 and 2 is that participants in Experiment 1 may have been confused about the task (especially the rejection task) without proper feedback. Experiment 3 emphasized the task frame with a modified version of the questionnaires. The modifications in the questionnaire included: (a) highlighting the word “choose” or “reject” in the instruction in bold and red; (b) reducing the number of questions from 30 to 15 for each participant; (c) including a practice question with clearly better and worse options at the beginning of the experiment, for which participants would get prominent feedback if they did not follow the task correctly; (d) adding a final question at the end to test the participant on whether the task was to select or to reject an option to determine whether s/he understood the task. The purpose of these modifications was to reduce or eliminate the possibility that participants in the rejection task mistake the task as a selection task, and thus to distinguish the accentuation and compatibility accounts without this possible confounding.

EXPERIMENT 3A MTURK PARTICIPANTS

Method

Participants and Experiment Platform

For faster and more convenient data collection, 604 participants were recruited from Amazon Mechanical Turk (MTurk; www.mturk.com). MTurk is a large online crowdsourcing platform that allows “requesters” (e.g., social science researchers, business firms) to collect human-intelligence data from “workers”, who perform the tasks (named as Human Intelligence Task, or HIT) posted by the requesters and get paid (or sometimes for free). The MTurk workers for this and later MTurk experiments were required to be located in US and have a HIT approval rate equal to or greater than 95%.

Apparatus, Stimuli, Design, and Procedure

The apparatus, stimuli, design, and procedure were similar to Experiment 1 except the following aspects. The experiment was posted on MTurk and took about 10 minutes on average with a payment of $0.25. At the very beginning of the experiment, participants were shown a unique picture taken by the researcher (see Figure 8), and they were told to participate in the experiment only if this was the first time they saw the picture. This same procedure was used in all the MTurk experiments throughout this study to try to ensure that participants participated in the experiment only once and had not participated in other similar experiments from this study.

To increase the quality of the responses, each participant answered 15 problems randomly drawn from the total 30 problems. The relative location of the enriched option and the impoverished option was randomized for each problem. In the instructions, participants in the selection condition were told, "For each problem you need to **choose** [in red] an option you like." Those in the rejection condition were told, "For each problem you need to **reject** [in red] an option you dislike." In addition to these instructions, the following practice problem was presented to all participants before they started the 15 problems:

> Imagine that you were invited to play one of the following two lotteries.
>
> Which one would you **prefer (reject)**?
>
> A a 100% chance to win $60 B a 100% chance to lose $60

One (i.e., A) of the two options of this practice problem clearly dominates the other one (i.e., B), and it was assumed that participants in the selection condition would click on A, and those in the rejection condition would click on B if they understood the task correctly and were paying enough attention. When participants clicked on the intended option, they would see, "Please note: For all the following problems You need to select the option you prefer (reject) [in red]!" Otherwise, they would see a warning sign (see Figure 9), and the statement, "Please pay more attention! You need to select the option you prefer (reject) [in red]!" Finally, after participants completed all 15 problems, they were asked "For the problems you have completed, what were you asked to do?” and provided the two options “To select an option” and “To reject an option”. This test question was designed to check whether participants understood the task frame correctly. After answering two demographic questions regarding their age and gender, participants were given a random code that they could input into MTurk to get paid.

Results

For the practice question, 5 out of 302 participants in the selection condition answered it incorrectly by selecting the gamble that had a 100% chance to lose $60; a higher portion, 48 out of 302 participants in the rejection condition chose to reject the option with a 100% chance to win $60. These participants were notified about the task frame again and were warned to pay more attention. Four participants in the selection condition and two in the rejection condition answered the last test question incorrectly, and they were excluded from the following analyses. The same RT cutoffs used in Experiment 1 were used in this experiment for excluding the outlier trials (the fixed reading-speed lower cutoff and the 500 ms upper cutoff excluded 16.0% and the $M \pm 3$ *SD* cutoff excluded 1.6% of the total trials).

Choice Data

Figure 10 shows the regression lines of the two tasks. The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option in both the selection task, $F(1, 28) = 1014.37$, $p < .001$, $R^2 = .986$, $R^2_{\text{Adjusted}} = .972$, and the rejection task, $F(1, 28) = 767.76$, $p < .001$, $R^2 = .982$, $R^2_{\text{Adjusted}} = .964$. The coefficients of the two regression functions were significant, for both the selection task, $Beta = 1.070$, $t(29) = 31.85$, $p < .001$, and the rejection task, *Beta* = 0.930, $t(29) = 27.71$, $p < .001$. Although the difference between the two coefficients was smaller, it was statistically significant, $t(29) = 2.93$, $p = .005$.

Decision Time

The mean time to complete each problem was used for the timing analysis. There was a main effect task frame (*M*s = 22.97 vs. 25.57 s for selection and rejection tasks, respectively), $F(1, 29) = 70.82$, $p < .001$, $\eta_p^2 = .71$, and a significant interaction between task frame and feature order, $F(1, 29) = 7.69$, $p = .010$, $\eta_p^2 = .21$. For positive-negative feature order, the mean RT was 23.13 for the selection task and 25.13 for the rejection task; for negative-positive feature order, the mean RT was 22.81 for both the selection and 26.01 for the rejection task. The main effect of feature order was not significant, $F(1, 29) = 1.75$, $p = .197$, $\eta_p^2 = .06$.

EXPERIMENT 3B SONA PARTICIPANTS

Method

The purpose of this experiment was to test whether the difference between Experiments 1 and 3A was due to the participant population or to the changes in the survey design. The same experiment as in Experiment 3A was conducted on a total of 601 participants recruited through the Sona system. Participants in this experiment had not participated in other similar experiments and were granted 1 research credit towards the course requirements.

Results

The same data analysis procedure for Experiment 3A was used. For the practice question, 4 out of 304 participants in the selection condition answered it incorrectly by selecting the gamble that had a 100% chance to lose $60; 31 out of 299 participants in the rejection condition chose to reject the option with a 100% chance to win $60. These participants were notified about the task frame again and were warned to pay more attention. Twelve participants in the seleciton condition and seven in the rejection condition were excluded from subsequent analyses because they gave an incorrect answer to the last test question. The fixed cutoffs excluded 10.8% and the $M \pm 3$ *SD* cutoff excluded 1.9% of the total trials.

Choice Data

Figure 11 shows the regression lines of the two tasks. The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option in both the selection task, $F(1, 28) = 1054.46$, $p < .001$, $R^2 = .987$, $R^2_{\text{Adjusted}} = .973$, and the rejection task, $F(1, 28) = 515.28$, $p < .001$, $R^2 = .974$, $R^2_{\text{Adjusted}} = .947$. The coefficients of the two regression functions were significant, for both the selection task, *Beta* = 1.177, $t(29) = 32.47$, $p < .001$, and the rejection task, *Beta* = 0.823, $t(29) = 22.70$, $p < .001$. More importantly, the difference between the two coefficients was also significant, $t(29) = 6.91$, $p < .001$.

Decision Time

The mean time to complete each problem was used for the timing analysis. None of the terms was significant: For the main effects of task frame and feature order, *F*s < 1, and for the interaction between the two factors, $F(1, 29) = 2.00$, $p = .168$, $\eta_p^2 = .06$.

Discussion

The redesigned questionnaire used in Experiment 3 yielded a smaller task frame effect than that in Experiment 1, yet the effect was still significant and conformed to the accentuation account. Experiment 3 included clear task instructions emphasizing the task frames, a practice question at beginning with feedback, and a test question at the end for screening confused participants. These manipulations should have reduced, if not eliminated, the possible confusion participants had on the task frame. In addition, Experiment 3B was conducted on the same population and the same online platform (Sona) as Experiment 1.

Results in both Experiments 3A and 3B showed a task framing effect qualitatively similar to the effect found in Experiment 1, in which participants were more discriminating under the selection task frame than under the rejection one, again supporting the accentuation account. Note that the task framing effect (i.e., the difference between tasks) did become smaller in Experiment 3 than that in Experiment 1, indicating that task confusion likely was a contributor in the effect found in Experiment 1, though it cannot be the whole story. These results indicate that the null task framing effect in Experiment 2 was due to both reasons discussed earlier: elimination of task confusion in the rejection task and need for verbalization of reasons.

EXPERIMENT 4. ONLINE ATTRACTIVENESS JUDGMENT TASK

Wedell (1997) used the overall proportion of the enriched option being preferred as the index for the relative attractiveness of the enriched option, as did the previous experiments in the current study. The purpose of Experiment 4 was to directly obtain the attractiveness ratings of the options by requiring participants to rate the likelihood that they would *select* (or *reject*) an option when only one option was presented. Another purpose was to test whether the attractiveness judgment was influenced by the framing of the question.

Method

Participants

A total of 300 participants were recruited through MTurk. The same screening requirements for MTurk workers in Experiment 3 were used. The experiment took about 9.5 minutes on average and the payment was $0.50. The same picture was used to require that the participants had not participated in a similar study before.

Apparatus, Stimuli, Design, and Procedure

In the instruction, participants were told, "You will be presented with a number of problems, for each of which you need to rate the likelihood that you will **choose** (**reject**) [in red] a given option for that problem." The ratings were done for each of the two options in each problem, and each rating question only included one option, so there were in total 60 distinct rating questions. Each participant performed on 30 questions that were randomly selected from the total 60 questions. Participants were told to take as much time as they need to complete all 30 questions, and the time to complete each question was not recorded. In the *positive* condition, the question was presented along with one option, and participants were asked, “How likely will you choose [this option]?” on a 10-point scale (1 = very unlikely; 10 = very likely). In the *negative* condition, participants were asked, “How likely will you choose [this option]?” Participants were randomly assigned to one of the two conditions. Similar to Experiment 3, a practice question was presented to the participants at the beginning of the experiment:

> Imagine that you were to play a lottery. One lottery has a 100% chance to win $60.
>
> How likely will you choose (reject) to play this lottery?

It was expected that participants in the positive condition would give a rating among 6 to 10 for the likelihood of choosing this lottery and participants in the negative condition would give a rating among 1 to 5 for the likelihood of rejecting this lottery. When they gave a rating within the expected range for this practice question, participants saw a the message, “Please note: For all the following questions You need to rate the likelihood that you will choose [in red] the option!”; otherwise, they saw the warning sign shown in Figure 5 along with the statement, “Please pay more attention! You need to rate the likelihood that you will choose (reject) [in red] the option!” Each participant completed 30 questions randomly selected from all 60 questions.

Results

One participant whose age was less than 18 years was excluded from the subsequent analyses.

For the practice question (One lottery has a 100% chance to win $60), which should have an obvious rating of attractiveness (high likelihood to choose to play this lottery or low likelihood to reject to play this lottery). In the positive rating task, 98.1% of the participants rated the likelihood to choose to play this lottery higher than or equal to 6, 88.8% of whom rated it as 10; in the negative rating task, only 61.4% of the participants rated the likelihood to reject to play this lottery lower than or equal to 5, 88.7% of whom rated it as 1; more importantly, 33.1% of the participants rated it as 10, who clearly misunderstood the task (see Table 1). As to the final test question asking what the task was, only three participants answered incorrectly and they were further excluded from subsequent analyses.

The ratings in the negative condition were transformed by subtracting them from 11 (= 11 − rating) to get the attractiveness rating used in the following analysis. An ANOVA was used to test (see Carifio & Perla, 2007) the effects of task frame (positive vs. negative), option type (enriched vs. impoverished), and feature order (positive-negative vs. negative-positive) on the attractiveness ratings. The results showed only a significant effect of enriched vs. impoverished option, and the enriched options were rated less attractive than the impoverished options (Ms = 5.19 vs. 6.33). No other effects were significant, Fs < 1.30.

The more important purpose of this experiment was to obtain the relative attractiveness rating of the enriched option through direct rating. The mean rating for each option in each problem was computed across all valid participants in both the positive and negative tasks given that the task frame term was not involved in any significant effect in the above ANOVA analysis. The relative attractiveness was calculated by the following formula:

$$Attr(Enriched) = 0.5 + \frac{R(Enriched) - R(Impoverished)}{R(Enriched) + R(Impoverished)},$$

where *Attr* stands for the relative attractiveness score, *R* stands for the mean rating.

Discussion

For the practice question, less than 10% of the participants in the positive rating task were confused by or not paying attention to the task, yet nearly 40% of the participants in the negative rating task seemed to fall in one or the other of these categories. This discrepancy indicates that it is easier for people in the positive rating to understand the task than people in the negative rating task, in line with the findings in previous experiments that participants were more easily confused in the rejection task than in the selection task. In addition, the results demonstrate the necessity of including such practice questions in this type of study to help participants understand the task and prevent misunderstanding, especially when the study is conducted online. The high accuracy rates in the final test question for both positive and negative rating tasks indicate that the warning feedback following the practice question was effective in reminding people of the actual task requirement.

The task framing in this experiment did not have an influence on participants' judgments. This result was not consistent with the compatibility account, which would predict the enriched option to be rated as more attractive in the positive rating task than in the negative rating task because people put more weights on the positive features in the positive task and on the negative features in the negative task. As to predictions from the accentuation account, on the one hand, it emphasizes accentuation of the difference between options in the selection task. In the current judgment task, each option was presented separately from the other one in the same problem, and thus no accentuation of difference existed in the current setting.

On the other hand, the accentuation account proposes that the difference between the two tasks is because different levels of commitment are involved in the tasks. Ganzach (1995) compared the judgment and choice tasks, and claimed that judgment task involves less commitment than choice task because “people have to live with the outcome of their choices but not with the output of their judgments” (p. 114). It is possible that the present found no difference in the positive and negative rating tasks was due to there being not much commitment involved in either tasks. Thus, the current results were at least not against the accentuation account.

The relative attractiveness index was then used to replace the overall proportion of preferring the enriched option in the previous and later experiments, and similar result patterns were obtained. The new regression plots are presented below the original plots in the figures for each experiment (see Figures 2, 3, 9, 10, 11, 12, and 13).

EXPERIMENT 5. IN-LAB CHOICE TASK WITH EYE-TRACKING

The purpose of this experiment was to examine the information-processing pattern through tracking eye movements while participants work on the problems under the selection and rejection task frames. The compatibility account predicts that participants will focus on the features that are more compatible with the task (i.e., focus on positive features or the best values when selecting and on the negative features or the worst values when rejecting), regardless of the overall relative attractiveness difference between the enriched and impoverished options. In contrast, the accentuation account predicts that participants will focus on the differences between alternatives in selection tasks but not so much in rejection tasks. Thus, under this assumption, participants will compare between the alternatives more in the selection task, and there will be more eye-movement transitions between the alternatives on the same features.

Given that the degree of accentuation is proposed to be based on the different levels of commitment in the two tasks, the accentuation account also predicts that people in the selection task will “pay more attention or be more willing to repeatedly sample reasons” than in the rejection task due to greater need for justification in the selection task.

This experiment employed number of fixations and total time spent as measures of amount of effort and information search, mean fixation duration as a measure of processing depth, and relative ratio of different types of fixation transitions (alternative-based vs. attribute-based) as a measure of information search pattern.

Method

Participants

A total of 49 participants (17 female, age 19.5 ± 1.2) from the same subject pool as those in Experiments 1 and 2 were recruited from SONA. These participants had not participated in previous experiments.

Apparatus and Stimuli

A Tobii X-60 (Tobii Technology AB, Danderyd, Sweden) eye tracker and the iMotions Attention Tool 5.3 software (iMotions Inc., Cambridge, MA) were used to record the eye movements of the participants during the experiments. The stimuli were presented on a 23″ monitor that was connected with the eye tracker. The same questionnaire used in Experiment 3 was used in this experiment, with some minor wording modifications to fit each feature in one single line when presented on the computer screen connected to the eye tracker.

Design and Procedure

Half of the participants performed the selection task, and the other half performed the rejection task. The order of the 30 problems was randomly assigned for each participant. In each problem, participants will be shown the problem statement (on top) and two options (below the problem statement, side by side) simultaneously on the screen. The position (left vs. right) of the enriched option relative to the impoverished option, and the order of the features within each option were treated as control variables by being counterbalanced between-subjects within each task conditions. Thus, for example, among the 24 participants who performed the selection task, 6 participants saw the enriched option to the left (or right) of the impoverished option and the positive features above (or below) the negative features within each option. Each attribute was defined as an area of interest (AOI). The AOIs were of the same size, large enough to cover the longest feature of all problems, and were not overlapped. Fixations on other areas were not considered for further analysis.

Results

One participant was excluded from the subsequent analyses due to the failure to follow the instruction to look at the computer screen during the experiment.

Choice Data

The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option in both the selection task (see Figure 12), $F(1, 28) = 490.17$, $p < .001$, $R^2 = .946$, $R^2_{\text{Adjusted}} = .944$, and the rejection task, $F(1, 28) = 216.48$, $p < .001$, $R^2 = .885$, $R^2_{\text{Adjusted}} = .881$. The coefficients of the two regression functions were significant, for both the selection task, *Beta* = 1.202, $t(29) = 22.14$, $p < .001$, and the rejection task, *Beta* = .798, $t(29) = 14.71$, $p < .001$. More importantly, the difference between the two coefficients was significant, $t(29) = 5.25$, $p < .001$.

Eye-Movement Data

The problem statement and each of the features were defined as AOIs (areas of interest), and the following data for each AOI in each problem page were obtained by averaging across participants in each task condition: number of fixations (for fixaitons equal to or longer than 100 ms), fixation duration (ms; the duration of each fixation), time spent (ms; the sum of the durations of all fixations within the AOI), time spent percent (%; the percent of the time spent out of the total time spent on the page).

The features within each option were then grouped into positive vs. negative features by collapsing the positive features (2 or 3 out of 5 total features, or 1 out of 2 features) and the negative features (3 or 2 out of 5 totaol features, or 1 out of 2 features) for the following analyses. Each problem was treated as an experimental unit in repeated-measure ANOVAs for time spent, time spent percent, number of fixaitons, and fixation duration, with feature valence (positive vs. negative), option (enriched vs. impoverished), and task (selection vs. rejection) as within-subject variables.

Number of fixations. The only significant effect was the main effect of the option type, $F(1, 29) = 4.34$, $p = .046$, $\eta_p^2 = .13$. There were more fixations on the enriched option ($M = 6.99$) than on the impoverished option ($M = 6.58$). No other effects were significant, ps $\geq .195$. The means were 6.84 for the selection task and 6.73 for the rejection task. Although the data on the problem instructions were not included in the current analysis, for the purpose of completeness, the number of fixations on the problem instructions did not differ across the two tasks (Ms = 21.43 vs. 21.71), $t(29) = 0.43$, $p = .672$.

Average fixation duration. There was a significant main effect of option type, $F(1, 29) = 8.53$, $p = .007$, $\eta_p^2 = .23$, and an interaction between option type and task, $F(1, 29) = 12.67$, $p = .001$, $\eta_p^2 = .30$. The enriched option had longer average fixation durations ($M = 216$ ms) than the impoverished option did ($M = 212$ ms). These differences were mainly due to the interaction that the enriched option had longer fixation durations in the rejection task (*M*s = 219 vs. 212 ms), but not in the selection task (*M*s = 212 vs. 211 ms). The selection task tended to have shorter average fixation durations (*M* = 212 ms) compared to the rejection task (*M* = 215), $F(1, 29) = 3.80$, $p = .061$, $\eta_p^2 = .12$. No other effects were significant, *F*s < 1.02. Again, no difference in the average fixation durations on the problem instructions, (*M*s = 204 vs. 207 ms), $t(29) = .65$, $p = .523$. Note that although the difference in average fixation duration in the current experiment was relatively small, there were previous studies that found significant differences of similar size. For example, Rubaltelli et al. (2012) found a 9-ms difference between a pricing task and an attractiveness rating task (*M* = 203 vs. 194 ms) and concluded “deeper and more deliberative processing” in the former task.

Time spent. This is a measure of how much participants spent on the features in the options. The only significant effect was the main effect of the option type (*M*s = 1552 and 1415 ms for enriched and impoverished options, respectively), $F(1, 29) = 6.51$ $p = .016$, $\eta_p^2 = .18$. No other effects were significant, *p*s ≥ .168. The mean time spent was 1458 in the selection condition and 1480 in the rejection condition. There was no difference in time spent on the problem instruction in the two tasks (*M*s = 4547 vs. 4607 ms), $t(29) = .41$, $p = .688$.

Percent of time spent. This is a measure of the ratio of the time spent on the features to the time spent on the whole page. There was a significant main effect of task (*M*s = 6.34% vs. 6.17% for selection and rejection tasks, respectively), $F(1, 29) = 6.00$, $p = .021$, $\eta_p^2 = .17$. No other effects were significant, *p*s ≥ .101. There was no difference for the problem instructions (*M*s = 17.66% vs. 18.42%), t (29) = 1.70, p = .100.

Fixation transitions. An alternative-based transition was defined if a fixation transition was made within the same alternative, and an attribute-based transition was defined if the transition was made from one alternative to the other on the same attribute. A repeated-measure ANOVA was conducted on the number of fixation transitions with transition type (alternative-based vs. attribute-based) as a within-subject variable and task frame (selection vs. rejection) as a between-subject variable. There was only a main effect of transition type (*M*s = 10.35 vs. 4.26 for alternative- and attribute-based transitions, respectively), $F(1, 1436) = 1409.39$, $p < .001$, $\eta_p^2 = .50$. No other effects were significant, *F*s < 1. A similar result pattern was obtained when computing the fixation transitions in the form of Payne index (Payne, 1976), which equals to the ratio of the difference between the numbers of the alternative- and attribute-based transitions and the sum of the two numbers.

Since there was no effect of the feature valence, the same analyses were conducted by grouping all the features in each option altogether rather than grouping them into the positive and negative two groups. Each problem was again treated as an experimental unit in repeated-measure ANOVAs for time spent, time spent percent, number of fixaitons, and fixation duration, with option (enriched vs. impoverished), and task (selection vs. rejection) as within-subject variables.

Number of fixations. The only significant effect was the main effect of the option type, $F(1, 29) = 7.03$, $p = .013$, $\eta_p^2 = .20$. There were more fixations on the enriched option ($M = 29.44$) than on the impoverished option ($M = 27.01$). No other effects were significant: For the main effect of task frame (*M*s = 28.78 vs. 27.67), $F(1, 29) = 2.71$, $p = .110$, $\eta_p^2 = .09$, and for the 2-way interaction, $F(1, 29) = 3.61$, $p = .068$, $\eta_p^2 = .11$. In the selection task, *M*s = 29.70 vs. 27.87 for the enriched vs. impoverished options, respectively; in the rejection task, *M*s =29.19 vs. 26.16 for the enriched vs. impoverished options, respectively.

Average fixation duration. There were significant main effects of task, $F(1, 29) = 12.83$, $p = .001$, $\eta_p^2 = .31$, and option type, $F(1, 29) = 11.67$, $p = .002$, $\eta_p^2 = .29$, and an interaction between option type and task, $F(1, 29) = 9.30$, $p = .005$, $\eta_p^2 = .24$. The selection task had shorter average fixation duration ($M = 211$ ms) than the rejection task ($M = 217$ ms). The enriched option had longer average fixation durations ($M = 216$ ms) than the impoverished option did ($M = 211$ ms). These differences were mainly due to the interaction that the enriched option had longer fixation durations in the rejection task (*M*s = 221 vs. 213 ms), but not in the selection task (*M*s = 212 vs. 210 ms).

Time spent. This is a measure of how much participants spent on the features in the options. There was a significant main effect of the option type (*M*s = 6417 and 5789 ms for enriched and impoverished options, respectively), $F(1, 29) = 10.53$, $p = .003$, $\eta_p^2 = .27$, and a significant interaction between option type and task, $F(1, 29) = 5.44$, $p = .027$, $\eta_p^2 = .16$. The difference between the two options was larger in the rejection task (*M*s = 6481 vs. 5698 ms for enriched and impoverished options, respectively) than in the selection task (*M*s = 6353 vs. 5878 ms). The main effect of task was not significant, $F(1, 29) = .03$, $p = .871$, $\eta_p^2 = .00$. The time spent was 6115 ms in the selection condition and 6089 ms in the rejection condition.

Percent of time spent. There was a significant main effect of option type (*M*s = 25.98% vs. 23.79%), $F(1, 29) = 8.23$, $p = .007$, $\eta_p^2 = .22$. The main effect of task was approaching the .05 significance level (*M*s = 25.10% vs. 24.67% for selection and rejection tasks, respectively), $F(1, 29) = 3.53$, $p = .071$, $\eta_p^2 = .11$. The interaction between the two factors was not significant, $F(1, 29) = 2.84$, $p = .103$, $\eta_p^2 = .09$.

Discussion

The choice data showed that participants in the selection condition were more discriminating than those in the rejection condition, again supporting the accentuation account. This result pattern was consistent with the previous experiments, except Experiment 2 (verbal protocols). Note that participants in this experiment were well aware of the tasks because of the first practice question and reminders from the experimenter. This different pattern from Experiment 2 provides evidence that the overlapping of the two regression lines in Experiment 2 was due to the need of justification for the choice.

The eye-movement data did not show as rich patterns regarding the task frame as expected, however, there were some interesting results worth mentioning. The average fixation duration, which is a measure for cognitive effort, was longer in the rejection than in the selection task. Participants in the rejection task spent more effort on the options than those in the selection task. In addition, although time spent did not show a difference between the two tasks, the analysis on time spent percent showed a tendency for a higher percent in the selection than in the rejection task. These results indicate that although participants spent roughly the same amount of the time on the options, those in the rejection task spent more time on other information other than the options. These differences imply the same speculation as in previous question that the rejection task may require more cognitive effort and cause more confusion.

EXPERIMENT 6. ONLINE CHOICE TASK WITH TIME PRESSURE

The accentuation account proposes that the difference between the alternatives is accentuated more in the selection task than in the rejection task. Is this accentuation an automatic process or a deliberative process? Is the accentuation process fast enough not to be influenced by time pressure? Under time pressure, people tend to rely more on automatic processes and reduce analytic processes (e.g., Finucane et al., 2000). If the accentuation of alternative difference is deliberative, then the task framing effect should be reduced under time pressure; if the accentuation is automatic and fast, then the task framing effect should remain the same under time pressure. The purpose of this experiment was to investigate how time pressure affects the role of task frame, and thus understand the nature of the accentuation process.

Method

Participants

A total of 606 participants were recruited from MTurk using the same procedure as in Experiment 3.

Apparatus, Stimuli, Design, and Procedure

The same questionnaire used in Experiment 3 was used, but with time constraints. The mean and standard deviation for the time to submit each problem in each of the selection and rejection tasks in Experiment 3 were obtained and used to compute the time limit for each problem. The time allowed for answering each problem was one standard deviation below the mean, which has been commonly used in previous studies (e.g., Huber & Kunz, 2007). For each problem, the time remaining was indicated by a countdown timer at the bottom of the screen.

Results

For the practice question, 5 out of 306 participants in the selection condition answered it incorrectly by selecting the gamble that had a 100% chance to lose $60; 32 out of 300 participants in the rejection condition chose to reject the option with a 100% chance to win $60. These participants were notified about the task frame again and were warned to pay more attention. Two participants in the selection condition and seven in the rejection condition answered the last test question incorrectly, and they were excluded from the following analyses. Only the fixed reading time lower cutoff was used to exclude outlier trials. The 500 ms upper cutoff and the $M \pm 3$ *SD* cutoff were not used because the predetermined time limit used for each problem served as an upper cutoff. For two problems (#14 and 27), the computed time limits were shorter than the least reading times in the selection condition, and these two problems were eliminated from subsequent analyses. The reading time cutoff excluded 33% of the total trials for the rest 28 problems.

Figure 13 shows the regression lines of the two tasks. The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option in both the selection task, $F(1, 28) = 470.46$, $p < .001$, $R^2 = .948$, $R^2_{\text{Adjusted}} = .946$, and the rejection task, $F(1, 28) = 288.81$, $p < .001$, $R^2 = .917$, $R^2_{\text{Adjusted}} = .914$. The coefficients of the two regression functions were significant, for both the selection task, *Beta* = 1.122, $t(29) = 21.69$, $p < .001$, and the rejection task, *Beta* = 0.878, $t(29) = 17.00$, $p < .001$. The difference between the two coefficients was significant, $t(29) = 3.33$, $p = .002$, and this difference did not differ from the corresponding difference in Experiment 3A, $t\,(108) = 1.22$, $p = .226$.

Decision Time

The mean time to complete each problem was used for the timing analysis. There was a main effect of task frame (*M*s = 12.08 vs. 12.71 s for selection and rejection tasks, respectively), $F(1, 27) = 9.82$, $p = .004$, $\eta_p^2 = .27$, and a main effect of feature order (*M*s = 12.36 vs. 12.42 s for positive-negative and negative-positive orders, respectively), $F(1, 27) = 4.76$, $p = .038$, $\eta_p^2 = .15$. The interaction between task frame and feature order was not significant, $F(1, 27) = 3.32$, $p = .080$, $\eta_p^2 = .11$.

Discussion

The average decision time was 12.4 s, which was approximately half of the average time in the previous three online experiments (26.5 s in Experiment 1 with Sona participants, 24.3 s in Experiment 3A with MTurk participants, and 26.9 s in Experiment 3B with Sona participants). One of the MTurk workers sent an email to me stating that the task was “stressful but interesting”. Although this experiment did not directly measure participants’ perception of the time pressure, the time pressure manipulation seems to be successful.

Under time pressure, the same task framing effect explained by the accentuation account was found, of similar size as in previous experiments. That the time pressure did not influence the task framing effect indicates that the accentuation process seems to be relatively automatic. This would also explain why the verbal protocols method in

Experiment 2 eliminated the task framing effect: the requirement for verbalization of reasons promoted more deliberative thinking, which may have overridden the automatic processes of accentuating the difference between alternatives more in the selection task, and thus led to the null task framing effect.

EXPERIMENT 7. ONLINE CHOICE TASK “ANTI” TIME PRESSURE

Although it is convenient and efficient in data collection, one problem with collecting data on MTurk is that the workers may work through the problems as fast as they can by default so that they can move on to the next HIT posted by other people. This default status may have imposed implicit time pressure on the workers, which may be a problem for many other online platforms too. In Experiments 3A and 6, By excluding the answers that were given in a very short time (e.g., the time needed to read only the two options in each problem at the fast average reading speed), I have tried to solve this issue implicit time pressure in data analyses. The purpose of the current experiment was to provide a solution while participants performed the tasks, by forcing a “waiting time” for each problem. Participants had to wait a certain amount of time before they could click on the “next” button to submit their answers.

Method

Participants

A total of 600 participants were recruited from MTurk using the same procedure as in Experiment 3.

Apparatus, Stimuli, Design, and Procedure

The same questionnaire used in Experiment 3 was used, but with different time constraints. Unlike in Experiment 6, participants were encouraged to take as much time as they need, and they had to wait a certain amount of time (i.e., the *mean* for the time to submit each problem in each task in Experiment 3) before they could respond to each problem. Each problem was presented for the designated wait time without a "next" button, on which only by clicking were participants able to proceed. After this predetermined time window, the "next" button showed up at the right bottom of the page, and then participants could respond immediately or wait longer to respond.

Results

For the practice question, 1 out of 300 participants in the selection condition answered it incorrectly by selecting the gamble that had a 100% chance to lose \$60; 41 out of 300 participants in the rejection condition chose to reject the option with a 100% chance to win \$60. These participants were notified about the task frame again and were warned to pay more attention. Three participants in the selection condition and three in the rejection condition answered the last test question incorrectly, and they were excluded from the following analyses. The same cutoffs for response time as those in Experiment 3 were used. The fixed cutoff and the $M + 3\ SD$ cutoff excluded 0.04% trials in total.

Figure 14 shows the regression lines of the two tasks. The overall proportion preferring the enriched option explains a significant amount of the variance in the proportion preferring the enriched option in both the selection task, $F(1, 28) = 1315.12$, $p < .001$, $R^2 = .979$, $R^2_{\text{Adjusted}} = .978$, and the rejection task, $F(1, 2) = 860.76$, $p < .001$, $R^2 = .968$, $R^2_{\text{Adjusted}} = .967$. The coefficients of the two regression functions were significant, for both the selection task, *Beta* = 1.106, $t(29) = 36.27$, $p < .001$, and the rejection task, *Beta* = 0.894, $t(29) = 29.34$, $p < .001$. The difference between the two coefficients was significant, $t(29) = 4.91$, $p < .001$, and this difference did not differ from the corresponding difference in Experiment 3A, $t(112) = 1.13$, $p = 0.263$, or Experiment 6, $t(108) = 0.38$, $p = .702$.

Decision Time

The mean time to complete each problem was used for the timing analysis. There was a main effect of task frame (*M*s =29.02 vs. 32.63 s for selection and rejection tasks, respectively), $F(1, 29) = 118.84$, $p < .001$, $\eta_p^2 = .80$, and a main effect of feature order (*M*s = 30.42 vs. 31.23 s for positive-negative and negative-positive orders, respectively), $F(1, 29) = 28.66$, $p < .001$, $\eta_p^2 = .50$. The interaction between task frame and feature order was not significant, $F(1, 29) = 0.01$, $p = .945$, $\eta_p^2 = .00$.

Discussion

The mean decision time in this experiment (30.8 s) was longer than the mean in Experiment 3A (24.3 s) which was also conducted on the MTurk workers but with no specific time constraints. This difference is understandable because the forced waiting time in the present experiment was defined by the mean decision time in Experiment 3A in each problem. More interestingly, the regression lines for the choice data showed a very similar pattern in both experiments, which did not differ from the time pressure condition in Experiment 6 with a mean decision time of 12.4 s. Thus, the similar patterns in task framing effect revealed in Experiments 3A and 6 were not due to the implicit time pressure the MTurk workers may have in Experiment 3A. The results from this experiment validate the finding in Experiment 6 that the accentuation process is relatively automatic and is not affected by time pressure.

This finding should be welcomed by researchers who collect data on MTurk, yet a caution should be placed for collecting data on MTurk and other online platforms. Note that in Experiment 3A the reading-speed cutoff excluded approximately 16% of the total data, which indicates that at some participants were “rushing through” on some problems. With justifiable cutoff methods of excluding outliers, the data obtained with no time constraints could be taken as being as valid as when the waiting time was imposed on the participants. However, the loss of data due to the exclusion of outliers can be made up by running more people, given the efficiency of data collection on these platforms.

GENERAL DISCUSSION

The seven experiments, conducted in laboratory and online, used a variety of methods to examine how different task frames change the decision maker's preference. The predictions from the compatibility account and the accentuation account were tested. The compatibility account (Shafir, 1993) predicts the enriched option to be preferred more often under the selection task frame than under the rejection task frame, due to the reason that the more positive (negative) features in the enriched option are more compatible with and are thus weighted more the selection (rejection) task. The accentuation account (Wedell, 1997) predicts the more attractive option to be preferred more and the less attractive option to be preferred less in the selection task than in the rejection task, due to the rationale that people are more discriminating in the selection task with a higher level of commitment involved than in the rejection task. The results in all but one experiment fit with the prediction from the accentuation account.

Experiment 1 was conducted online on introductory psychology class students, with a plain statement for the task (either a selection or a rejection one), and a large difference between the two task frames (the task framing effect) was found as predicted by the accentuation account. In Experiment 2, participants were recruited from the same subject pool but were required to verbalize their thoughts while performing the same tasks in a laboratory. No difference between the two task frames in the choice data was found in this experiment, possibly due to the need for verbalization of reasons in Experiment 2 or the confusion about the rejection task in Experiment 1. With a modified version of the questionnaire conducted on both MTurk workers (Experiment 3A) and introductory psychology students (Experiment 3B), Experiment 3 emphasized the tasks in several different ways to reduce the possible confusion regarding the task, and a similar pattern as in Experiment 1 was evident though with a smaller effect size. Thus, it was established that task confusion cannot explain the task framing effect alone.

Experiment 4 used a judgment task, in which participants were required to rate the likelihood of selecting or rejecting an option. It was again found that more participants in the negative task did not understand the task correctly before any feedback was provided. The ratings from this experiment were used as direct attractiveness measures and a similar task framing effect was found with these measures. The finding of task framing effect was supported by the data from an eye-tracking experiment (Experiment 5), in which participants were invited to the lab performing the tasks without being required to verbalize their thoughts. In the last two experiments, whether the task framing effect was influenced by time pressure was tested. Experiment 6 imposed time limits on participants and required them to respond within a short time, whereas Experiment 7 forced participants to wait a certain amount of time before they could respond. Both experiments found a task framing effect that did not differ from that in Experiment 3A, which indicates that this task framing effect was relatively automatic and that it did not extra take time for people being more discriminating in the selection task than in the rejection task.

Positive Versus Negative Tasks

In the current choice tasks of Experiments 3A, 3B, 6, and 7, participants were first shown a practice question after the instructions. There was an obviously desirable option (i.e., a 100% chance to win $60) and an undesirable one (i.e., a 100% chance to lose $60) in the practice question. The logic was that if participants were paying attention and understood the task accurately, they would select the desirable option or rejection the undesirable one. A consistent finding was that more participants in the rejection task (*M* = 12.7% across experiments) answered the practice question incorrectly than those in the selection task (*M* = 1.2%). In Experiment 2 with the verbal protocols, 12 of the 20 participants in the rejection task took the task as a selection one without the experimenter's reminder, but none in the selection task mistook the task. Similarly in the judgment task of Experiment 4, participants were to rate their likelihood of choosing or rejecting a highly desirable lottery with a 100% chance to win $60. Consistent with the pattern in the choice tasks, more participants in the negative rating task (38.7%) showed task confusion or inattention than those in the positive rating task (1.9%).

There are several possible reasons for the difference between the two task frames. It is possible that some participants were not paying attention to what they were doing when performing a task online. These participants may have taken it for granted that the task was a positive one of selection or rating the likelihood of selection, because most online experiments they have encountered should involve a positive task. The same is true for most daily life problems, a simple example of which is that people typically purchase more than they return. In the worst case, some participants may click on an option randomly because the questions were supposed to reflect personal preferences. In the latter, the number of "random" participants should not differ under the two task frames because the problem was not elicited by the task per se, and thus the number should be very small because only less than 2% of the participants in the positive tasks did so.

In a study by Chen, Gates, Li, and Proctor (2015), participants were required to make a hypothetic decision on whether to install a mobile app. Along with other information such as user ratings, a risk or safety score in the form of filled circles was presented on for each app. Chen et al. found that this risk or safety score influenced participants' decision making that the higher (lower) the safety (risk) score, the more often the app was selected. Moreover, the safety score had a larger effect (i.e., people were more discriminating) than the risk score, similar to the comparison between the selection and rejection tasks in the current study. Chen et al. included a final test question to examine participants' understanding of the risk or safety symbols, and found that more people in the risk condition answered the test question incorrectly than in the safety condition. A follow-up analysis was conducted on the participants who identified the symbols correctly, and the difference between the safety and risk frames (i.e., the advantage for presenting a safety score) tended to be smaller but still significant. Although framing in Chen et al.'s study was not in terms of the task but the information, the result pattern similar to the current study indicates that a negative way of presenting the information in terms of risk could have led to more confusion than a positive way of presenting the information in terms of safety.

Another possible reason is that the greater task confusion in the negative task was due to its requiring more effort to understand than the positive task. With limited time and effort people may attribute to a task, the more difficult the task the more likely errors will occur. Moreover, the current data in Experiments (1, 3A, 3B, 6, and 7) showed that participants tended to spent more time under the rejection task frame than under the selection frame. In the eye-tracking experiment (Experiment 5), although the total time to complete each problem did not differ under the two task frames, the average fixation duration (a measure of cognitive effort) was longer in the rejection task than in the selection task. These data indicate that the rejection task may be more effortful and occupy more cognitive resources.

Improvement of the Accentuation Account

Accentuation of Difference?

The accentuation account proposes that the reason why participants are more discriminating in the selection task than in the rejection task is because the difference between attributes being accentuated more in the selection task, which involves a higher level commitment. As stated by Wedell (1997), “The accentuation hypothesis simply argues that greater commitment or need for justification in choice leads to greater weighting of attribute differences. In other words, people are more discriminating when choosing than when rejecting” (p. 874).

The current study showed the result pattern that is predicted by the accentuation account in the sense that participants were more discriminating in the selection task than in the rejection task. However, regarding the accentuation process, I argue that people have to process the features before knowing the difference, so that there is a leap to assume that the task frame actually influences how people weight the difference rather than to assume what is influenced is a process on the features per se. Thus, I propose that a more direct explanation is that people evaluate the positive features being more positive and/or the negative ones being more negative in the selection task, which yield to a greater discrimination in the selection than in the rejection task. This new way of looking at the accentuation process also makes it possible to extend the accentuation account to explain results from judgment tasks on each option individually, in which the difference between the options is not available within one problem.

Difference in Discrimination

Regarding the reason why people are more discriminating under the selection task frame than under the rejection task frame, I propose that available cognitive resource is a possible critical factor. The current experiments did not test directly the levels of commitment involved in the two tasks, neither did the previous studies by Ganzach (1995) or Wedell (1997). The assumption that the selection task involves more commitment than the rejection task was from the speculation that people need to live with the option they make in the selection task but not the one in the rejection task (Ganzach, 1995). Meloy and Russo (2004) tested the commitment level in both a selection and rejection tasks, using a subjective certainty rating as a measure, and found that the commitment level was not higher in the selection task than in the rejection task. Based on the current data, participants were more confused about the rejection task (Experiments 2, 3, 6, and 7), spent more time in the rejection task than in the selection task (Experiments 1, 3, 6, and 7), or had a longer average fixation duration in the rejection task than in the selection task (Experiment 5).

Consequently, it is reasonable to think that people in the rejection task have to spend part of their cognitive resource in understanding the task per se and thus less resource is available for the decisions to make. In the rejection task, if people have to put some effort into understanding the task itself, then they may not have as many resources to devote to the choice as people in the selection task. As a result, people in the rejection task are not as discriminating as those in the selection task. Thus, it is possible that people are more discriminating in the selection task because more available cognitive resources are available for discriminating between the options than in the rejection task, though the influence of different levels of commitment cannot be excluded without further empirical evidence.

Modified Accentuation Account

Based on the above evaluation, I propose a modified version of the accentuation account according to the above analyses. The selection versus rejection task frame has an influence on people's preferences, based on two assumptions: 1) People under the rejection task frame need to spend part of their cognitive resources to understanding the task, and thus have less cognitive resource available to discriminate the alternatives. 2) Compared to those under the rejection task frame, people under the selection task are more discriminating, the positive features appear to be more positive and the negative features to be more negative, and thus the more (less) attractive alternative becomes even more (less) attractive. In addition, because the task framing effect was not influenced by the time-pressure manipulation, the accentuation process seems to be relatively automatic.

Accounting for Previous Results

In this section, I discuss the applicability of this modified accentuation account in explaining some of the earlier studies in support of the compatibility account. The same logic that the difference under various task frames lies in the amount of available cognitive resource can be applied to the choice and matching tasks in Tversky et al.'s (1988) study, mentioned in Introduction. For a choice task, the participants only need to come up with one of the two alternatives, whereas for a matching task a specific number is required. The latter task seems to be more demanding, as the rejection task in the selection vs. rejection task pair. So when the participants were told that the technical-knowledge attribute was more important, they were better at cooperating this information into their decisions in the choice task than in the matching task because there is more available cognitive resource in the simpler choice task. This rationale can explain why 65% of the participants in the choice task indicated preference for the candidate with a higher technical-knowledge score whereas only 34% participants in the matching task did so. Note that this study cannot distinguish whether being more discriminating in one task than the other is due to the former task involving more commitment or being less effortful, because the choice task is less effortful than the matching task and also possibly involves more commitment because people need to live with the option they choose.

In Nowlis and Simonson's (1997) study, each of the two options in the problems contained one "comparable" feature and one "enriched" feature, and the comparable feature is easier to compare than the enriched feature. In their example problem with two alternative televisions, TV A had a low-quality brand (Magnavox) but low price ($209), and TV B had a high-quality brand (Sony) but high price ($309). The authors proposed that brand is an enriched feature and price is a comparable feature, which are compatible with a rating task and a choice task, respectively. The finding was that participants preferred the options with better brands like TV B more in the rating task than in the choice task. Using an average of the percentages that one option was preferred in both tasks, I obtained the relative attractiveness of this option. In all seven of Nowlis and Simonson's similar experiments, the options like TV B were more attractive (M = 56%) than the other options. In other words, participants were more discriminating (i.e., preferring the more attractive option like TV B more) in the rating task than in the choice task. According to the commitment explanation in the accentuation account proposed by Wedell (1997), higher level commitment should be involved in the choice task than in the rating task because people will need to live with the option they chosen but not the options they made a judgment through rating (Ganzach, 1995). In this way, the accentuation account is not able to account for the results from Nowlis and Simonson's study. However, one can assume that the rating task is less effortful than the choice task because the rating task involve only one option and the choice task requires an evaluation of both options. With this assumption proposed in the modified accentuation account, people have more cognitive resources available in the rating task to evaluate the features of an option, and thus become more discriminating, explaining the results.

The cognitive-resource view is also consistent with the compatibility account in some circumstances. For example, Slovic et al. (1990) found that when providing both market value and rank in market value of companies, participants weighted one of the two types of information (e.g., rank) more if they were required to predict the companies' performance for the next year in that type of information (e.g., rank). To explain this result in terms of the modified accentuation account, the effort demands for the two tasks need to be dependable on both the task and the information used. It is easier and less effortful to use the same type of information when making the prediction (e.g., to make a prediction on the rank when the ranks are available), which is also consistent with the compatibility principle.

The Compatibility Account

One possibility why the current study did not obtain a result pattern that fit with the compatibility account proposed by Shafir (1993) is that the compatibility effect becomes evident only in certain circumstances. As stated by Shafir, "Naturally, compatibility effects tend to be mild, and limited in their ability to influence decision" (p. 547). The compatibility account explains decision-making processes best when the alternatives are otherwise comparable and the decision is difficult. When the alternatives are clearly different in terms of attractiveness to the decision maker, slightly different weightings of the positive and negative features should not affect the final choice. Similar to this idea, in Meloy and Russo's (2004) experiments that supported the compatibility account, the alternatives in each problem were controlled to be relatively equal in terms of attractiveness. Thus, the compatibility account may explain better for the problems with the options of similar attractiveness, and it may not be able to explain the results considering a broad range of relative attractiveness of the alternatives.

To test this possibility, I checked my data using the way Shafir (1993) analyzed his data, by comparing 100% with the sum of the percentage of the enriched option being selected (P_S) and that of it being rejected (P_R). A compatibility effect exists if the sum ($P_S + P_R$) is significantly greater than 100%, because according to the compatibility account the enriched option is preferred more in the selection task than in the rejection task ($P_S > 1 - P_R$). For each experiment (except Experiment 4), I ranked the problems by the relative attractiveness of the enriched option, and took the middle third of the problems to compare average of the sum ($P_S + P_R$) for the problems with those from the first and the last thirds of the problems. In *none* of the experiments was the average sum of the middle third higher than the numbers for the first and last thirds of the problems. Averaging across all experiments, the average sum was 94, 98, and 104 for the first, middle, and last thirds of the problems, respectively. Thus, it seems that whether the two options were similar in terms of attractiveness did not affect the evidence of the compatibility effect in the current study.

Compatibility From a Different Perspective

The compatibility in Shafir's (1993) account lies between the feature valence (positive vs. negative) and the task frame (selection vs. rejection). This compatibility relation requires the features within an option to be processed individually and interact with the task frame. Another way of looking at the compatibility relation is to treat each option as a unit, whose valence interacts with the task frame. These two layers of compatibility relation are similar to the element-level and set-level compatibility in the stimulus-response compatibility studies (e.g., Proctor & Wang, 1997). In this sense of option-based compatibility (compared with the previously defined feature-based compatibility), a more attractive option is more compatible with the selection task, and a less attractive option is more compatible with the rejection task. As a result, this option-based compatibility relation predicts that the more attractive options are preferred more in the selection task than in the rejection task, and the less attractive options are preferred more in the rejection task than in the selection task. This prediction fits exactly the data pattern found in the current study and that in Wedell's (1997) study.

This option-based compatibility account and the accentuation account are not mutually exclusive. It can be that the stimulus element that is more compatible with the task is weighted more heavily under this specific task than under other tasks, though these different weighting effects may not be evident when the options are very distinguishable in other aspects. In the meanwhile, some tasks are less effortful than others (e.g., selection task compared to rejection task, choice task compared to matching task) and people have additional available cognitive resources to focus on the decision per se in these less effortful tasks than in others.

Use of Verbal Protocols

In the current study, the verbal-protocol experiment (Experiment 2) demonstrated unique result patterns different from all other experiments. First, looking at the choice data, it was the only experiment in which the task framing effect was not evident. The regression lines for the selection and rejection tasks almost overlapped with each other, indicating that participants had similar preference patterns under both task frames. The principle of procedure invariance held in this experiment and the participants seemed to be "rational" according to the rational decision making theories. Second, in the verbal protocol data, participants tended to follow the compatibility principle by mentioning the features that are compatible with the task (e.g., positive features in the selection task). The above mentioned result patterns only occurred in Experiment 2, not in other experiments even when the task frame was emphasized and tested in the online experiments or when the participants were reminded about the task and monitored by the experimenter in the laboratory setting (Experiment 5). Thus, these patterns are apparently attributable to the task requirement that participants report their thoughts verbally while performing the tasks.

Caution should be taken when using the processing-tracing methods such as the verbal protocols and information board (e.g., Mouselab, Bettman, et al., 1990) Verbal protocol methods have been shown to influence the decision-making process rather than just revealing the process (e.g., Dickson, McLennan, & Omodei, 2000). Glöckner and Betsch (2008) compared results obtained using Mouselab with results obtained when the information was not restricted to participants, and found that using Mouselab introduced limitations in information search and more use of simple, non-compensatory strategies. The current study also showed that people became more "rational" and relied more on deliberative processing when required to verbalize their thoughts during the experiment. In addition, the need for verbalization of reasons may have promoted the reason-based processing, which is consistent with the compatibility account.

It was, however, beneficial to conduct an experiment with the verbal protocols method, which revealed interesting phenomena that would otherwise difficult to find out. Because participants were required to speak out their thoughts, I was able to discover that more than half of the participants in the rejection task thought the task was a selection one at the beginning. Another finding is that although the features in each option were predetermined to have positive, negative, or average values, these values could be very different for different participants. As an example, for a problem of selecting/rejecting one of two pairs of shoes, some participants thought "it appears as if everyone has a pair" was a good feature for shoes because it means the pair of shoes is popular for a good reason, but other said it was not good because they did not want to wear the same shoes as everyone else does.

Lessons for Conducting Experiments Online

The current study utilized both online and laboratory experiments: The online experiments provided choice and other response data of larger sample sizes, and the laboratory experiments obtained process-tracing data and other observations that are not available through online experiments. Conducting experiments online has become a complementary way of collecting data in laboratories. It usually works in the situations where the instructions are simple enough for participants to follow, the task does not require strict control (e.g., sound proofing), or no physical data (e.g., biometric measures) to be collected, and the required experimental population is able to and has access to internet and computer. Online experiments work better when time, budget, or human resource is limited, and a large number of participants is needed, the experiments need to be conducted in multiple locations, or the experiment is related to online contents (e.g., webpage design).

Besides the traditional university subject pool (e.g., the Sona system used in the current study), MTurk has become an increasingly popular platform for data collection in the areas of psychology and other social sciences in the past ten years (Paolacci, Chandler, & Ipeirotis, 2010). It has been concluded that MTurk is a viable alternative for data collection, the recruited population is relatively representative of the U.S. population, and the workers pay at least as much attention as participants from other platforms (Berinsky, Huber, & Lenz, 2012; Paolacci et al., 2010).

To ensure that the MTurk participants did not just rush through the task without paying attention or with an implicit time pressure to respond fast, I included an experiment in which the participants were forced to wait a certain amount of time (mean RT in an earlier experiment) before they were able to respond. A comparison between this experiment and a "usual" one without any timing manipulation would tell how the participants were doing in the usual experiments. It turned out that participants in both experiments used roughly similar amounts of time to finish the task and demonstrated similar result patterns. In addition, there *were* answers which were given only in a couple of seconds in the online experiments, which meant the participants did not even finish reading (part of) the contents before they responded. This type of fast response may be due to the participants not paying attention or just clicking on the "next" button mistakenly. In the analyses of all my online experiments, I included an RT cutoff to exclude this type of outliers to get cleaner data. In addition, a practice question with clear right or wrong answers was presented at the beginning of the online experiments to help participants understand the task. I would argue that these types of manipulation and comparison are necessary in conducting online experiments, especially when a timing manipulation is involved. Inserting several questions similar to the practice question throughout the experiment will also help to screen out participants who do not understand the task or do not follow the instructions.

Directions for Future Research

Wedell's (1997) accentuation account proposes that "greater commitment or need for justification in choice" (p. 874) leads to more accentuation in the selection task than in the rejection task. My modified version of the accentuation account proposes that available cognitive resources may be a critical factor that yields the difference between the two tasks. Neither Wedell's study or the current study measured level of commitment or need for justification directly in the tasks, and my inference that the rejection task is more effortful than the selection task is based on the performance data in the practice questions, the decision-time data, and the eye-tracking data. A possible direction for future studies is to measure directly the level of commitment or need for justification for the different tasks, and how effortful the tasks are.

The current study employed an information-processing approach to understand how people make decisions under different task frames. A pattern informed by the modified version of the accentuation account is that people evaluate the positive features to be more positive and the negative ones more negative. One question the current study did not answer directly is: What are the decision-making strategies people use when performing the tasks? Future studies can test the possible strategies (e.g., compensatory vs. non-compensatory strategies; Gigerenzer & Goldstein, 1996; Sütterlin, Brunner, & Opwis, 2008) people use, especially whether people use different strategies under different task frames and under different time-constrained situations.

The task framing effect studied in this dissertation can be applied to a number of tasks other than the daily-life problems used in the current experiments (e.g., to select a school to attend; to decide which product to return). For example, in the cybersecurity field, people usually need to perform certain tasks to permit or deny the use of their personal data depending on the default privacy setting (e.g., Lai & Hui, 2006), and people using smart devices often need to install or uninstall an application given various features of an application (e.g., Chen et al., 2014). Future studies can focus on investigating how different task frames influence people's decision making in these specific situations, and how to maintain better privacy and security in the cyber world by manipulating different task frames.

CONCLUSION

The current study provided evidence for the task framing effect that the selection versus rejection task frames influence the decision makers' preferences. People preferred the more (less) attractive option more (less) in the selection task than in the rejection, and this task framing effect was not influenced by time pressure. This result pattern supports the accentuation account (Wedell, 1997) that people are more discriminating in the selection task than in the rejection task.

In terms of theoretical contribution, I proposed a modified version of the accentuation account: Compared to those under the selection task frame, people under the rejection task frame have less cognitive resources available for discriminating the alternatives; the accentuation process makes evaluation of the positive (negative) features more positive (negative), and it seems to be automatic. I also discussed the implications of the current finding for the compatibility account. An option-level compatibility account rather than the feature-level compatibility account is consistent with the current finding, and previous studies supporting the compatibility account could possibly be explained in terms of the modified accentuation account.

In terms of methodological contribution, this study demonstrated a case of combining and comparing data from online and laboratory experiments, by collecting large-sample data online and obtaining information-processing patterns in the laboratory. In addition, I provided recommendations for conducting experiments involving different task frames online to make sure and/or examine whether participants understand the task frame as intended by the experimenter: To include a practice question with proper feedback at the beginning and a test question regarding the task frame at the end of the experiment.

LIST OF REFERENCES

LIST OF REFERENCES

Bergert, F. B., & Nosofsky, R. M. (2007). A response-time approach to comparing generalized rational and take-the-best models of decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*, 107-129.

Berinsky, A. J., Huber, G. A., & Lenz, G. S. (2012). Evaluating online labor markets for experimental research: Amazon.com's Mechanical Turk. *Political Analysis*, *20*, 351-368.

Bettman, J. R., Johnson, E. J., & Payne, J. W. (1990). A componential analysis of cognitive effort in choice. *Organizational Behavior and Human Decision Processes*, *45*, 111-139.

Bettman, J. R., & Zins, M. (1979). Information format and choice task effects in decision making. *Journal of Consumer Research, 6*, 141-153.

Brand, S., Reimer, T., & Opwis, K. (2003). Effects of metacognitive thinking and knowledge acquisition in dyads on individual problem solving and transfer performance. *Swiss Journal of Psychology*, *62*, 251-261.

Carlson, K. A., & Bond, S. D. (2006). Improving preference assessment: Limiting the effect of context through pre-exposure to attribute levels. *Management Science*, *52*, 410-421.

Carifio, J., Perla, R. J. (2007). Ten common misunderstandings, misconceptions, persistent myths and urban legends about Likert scales and Likert response formats and their antidotes. *Journal of Social Sciences*, *3*, 106-116.

Chen, J., Gates, C. S., Li, N., & Proctor, R. W. (2015). Influence of risk/safety information framing on android app-installation decisions. *Journal of Cognitive Engineering and Decision Making*, *9*, 149-168.

Chernev, A. (2009). Choosing versus rejecting: the impact of goal-task compatibility on decision confidence. *Social Cognition*, *27*, 249-260.

Colombo, L., Nicotra, E., & Marino, B. (2002). Preference reversal in decision making: The attraction effect in choice and rejection. *Swiss Journal of Psychology / Schweizerische Zeitschrift Für Psychologie / Revue Suisse De Psychologie*, *61*, 21-33.

Dhar, R., & Nowlis, S. M. (2004). To buy or not to buy: Response mode effects on consumer choice. *Journal of Marketing Research*, *41*, 423-432.

Dickson, J., McLennan, J., & Omodei, M. M. (2000). Effects of concurrent verbalization on a time-critical, dynamic decision-making task. *The Journal of General Psychology*, *127*, 217-228.

Diederich, A. (2003). MDFT account of decision making under time pressure. *Psychonomic Bulletin & Review*, *10*, 157-166.

Edland, A. (1993). The effects of time pressure on choices and judgments of candidates to a university program. In O. Svenson & A. Maule (Eds.), *Time pressure and stress in human judgment and decision making* (pp. 145-156). New York, NY: Plenum Press.

Edwards, W., & Fasolo, B. (2001). Decision technology. *Annual Review of Psychology*, *52*, 581-606.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making*, *13*, 1-17.

Fitts, P. M., & Deininger, R. L. (1954). SR compatibility: Correspondence among paired elements within stimulus and response codes. *Journal of Experimental Psychology*, *48*, 483-492.

Ganzach, Y. (1995). Attribute scatter and decision outcome: Judgment versus choice. *Organizational Behavior and Human Decision Processes, 62*, 113-122.

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. *Psychological Review, 103*, 650–669.

Gonzalez, C. (2003, October). Verbal protocols in real-time dynamic decision-making. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 47, No. 3, pp. 293-296). Santa Monica, CA: HFES.

Glaholt, M. G., & Reingold, E. M. (2011). Eye movement monitoring as a process tracing methodology in decision making research. *Journal of Neuroscience, Psychology, and Economics*, *4*, 125-146.

Glöckner, A. (2007). Does intuition beat fast and frugal heuristics? A systematic empirical analysis. In H. Plessner, C. Betsch, & T. Betsch (Eds.), *Intuition in judgment and decision making* (pp. 309-325). Mahwah, NJ: Lawrence Erlbaum.

Glöckner, A., & Betsch, T. (2008). Multiple-reason decision making based on automatic processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34*, 1055-1075.

Glöckner, A., & Herbold, A. K. (2011). An eye-tracking study on information processing in risky decisions: Evidence for compensatory strategies based on automatic processes. *Journal of Behavioral Decision Making*, *24*, 71-98.

Hertzum, M., & Holmegaard, K. D. (2015). Thinking aloud influences perceived time. *Human Factors,* 57, 101-109.

Hoyer, W. D. (1984). An examination of consumer decision making for a common repeat purchase product. *Journal of Consumer Research*, *11*, 822-829.

Huber, O., & Kunz, U. (2007). Time pressure in risky decision-making: Effect on risk defusing. *Psychology Science*, *49*, 415-426.

Kang, Z., & Landry, S. J. (2014). Using scanpaths as a learning method for a conflict detection task of multiple target tracking. *Human Factors*, *56*, 1150-1162.

Kornblum, S., Hasbroucq, T., & Osman, A. (1990). Dimensional overlap: cognitive basis for stimulus-response compatibility--a model and taxonomy. *Psychological Review*, *97*, 253-270.

Krishnamurthy, P., & Nagpal, A. (2010). Making choices under conflict: The impact of decision frames. *Marketing Letters*, *21*, 37-51.

Kuo, F. Y., Hsu, C. W., & Day, R. F. (2009). An exploratory study of cognitive effort involved in decision under Framing—an application of the eye-tracking technology. *Decision Support Systems*, *48*, 81-91.

Kuusela, H., & Pallab, P. (2000). A comparison of concurrent and retrospective verbal protocol analysis. *The American Journal of Psychology*, *113*, 387-404.

Lai, Y. L., & Hui, K. L. (2006). Internet opt-in and opt-out: investigating the roles of frames, defaults and privacy concerns. In *Proceedings of the 2006 ACM SIGMIS CPR conference on computer personnel research: Forty four years of computer personnel research: achievements, challenges & the future* (pp. 253-263). New York, NY: ACM.

Lichtenstein, S., & Slovic, P. (1971). Reversals of preference between bids and choices in gambling decisions. *Journal of Experimental Psychology*, *89*, 46-55.

Lichtenstein, S., & Slovic, P. (1973). Response-induced reversals of preference in gambling: An extended replication in Las Vegas. *Journal of Experimental Psychology*, *101*, 16-20.

Maule, A., Hockey, G., & Bdzola, L. L. (2000). Effects of time-pressure on decision-making under uncertainty: Changes in affective states and information processing strategy. *Acta Psychologica*, *104*, 283-301.

Meloy, M. G., & Russo, J. (2004). Binary choice under instructions to select versus reject. *Organizational Behavior and Human Decision Processes*, *93*, 114-128.

Nagpal, A., & Krishnamurthy, P. (2008). Attribute conflict in consumer decision making: The role of task compatibility. *Journal of Consumer Research*, *34*, 696-705.

Nowlis, S. M., & Simonson, I. (1997). Attribute-task compatibility as a determinant of consumer preference reversals. *Journal of Marketing Research*, *34*, 205-218.

Nursimulu, A. D., & Bossaerts, P. (2014). Risk and reward preferences under time pressure. *Review of Finance*, *18*, 999-1022.

Ordóñez, L., & Benson, L. (1997). Decisions under time pressure: How time constraint affects risky decision making. *Organizational Behavior and Human Decision Processes*, *71*, 121-140.

Orquin, J. L., & Loose, S. M. (2013). Attention and choice: A review on eye movements in decision making. *Acta Psychologica*, *144*, 190-206.

Paolacci, G., Chandler, J., & Ipeirotis, P. G. (2010). Running experiments on Amazon Mechanical Turk. *Judgment and Decision Making*, *5*, 411-419.

Payne, J. W., & Bettman, J. R. (2004). Walking with the scarecrow: The information-processing approach to decision research. In D. J. Koehler & N. Harvey (Eds.), *Blackwell handbook of judgment and decision making* (pp. 110-132). Malden, MA: Blackwell Publishing.

Payne, J. W., Braunstein, M. L., & Carroll, J. S. (1978). Exploring predecisional behavior: An alternative approach to decision research. *Organizational Behavior and Human Performance*, *22*, 17-44.

Peute, L. W., de Keizer, N. F., & Jaspers, M. W. (2015). The value of retrospective and concurrent think aloud in formative usability testing of a physician data query tool. *Journal of Biomedical Informatics*, *55*, 1-10.

Proctor, R. W., & Reeve, T. G. (Eds.). (1990). *Stimulus-response compatibility: An integrated perspective.* Amsterdam, The Netherlands: North-Holland.

Proctor, R. W., & Vu, K.-P. L. (2006). *Stimulus-response compatibility principles: Data, theory, and application*. Boca Raton, FL: CRC Press.

Proctor, R. W., & Wang, H. (1997). Set-and element-level stimulus-response compatibility effects for different manual response sets. *Journal of Motor Behavior*, *29*, 351-365.

Rubaltelli, E., Dickert, S., & Slovic, P. (2012). Response mode, compatibility, and dual-processes in the evaluation of simple gambles: An eye-tracking investigation. *Judgment and Decision Making*, *7*, 427-440.

Rubinstein, A. (2013). Response time and decision making: An experimental study. *Judgment and Decision Making*, *8*, 540-551.

Russo, J. E., Johnson, E. J., & Stephens, D. L. (1989). The validity of verbal protocols. *Memory & Cognition*, *17*, 759-769.

Schkade, D. A., & Johnson, E. J. (1989). Cognitive processes in preference reversals. *Organizational Behavior and Human Decision Processes*, *44*, 203-231.

Scholz, A., von Helversen, B., & Rieskamp, J. (2015). Eye movements reveal memory processes during similarity-and rule-based decision making. *Cognition*, *136*, 228-246.

Shafir, E. (1993). Choosing versus rejecting: Why some options are both better and worse than others. *Memory & Cognition*, *21*, 546-556.

Shafir, E., Simonson, I., & Tversky, A. (1993). Reason-based choice. *Cognition*, *49*, 11-36.

Shafir, E., & Tversky, A. (1995). Decision making. In E. E. Smith & D. N. Osherson (Eds.), *An invitation to cognitive science, Second Edition* (Volume 3: Thinking; pp. 77-100). Cambridge, MA: MIT Press.

Slovic, P. (1995). The construction of preference. *American Psychologist*, *50*, 364-371.

Slovic, P., Griffin. D., & Tversky, A. (1990). Compatibility effects in judgment and choice. In R. Hogarth (Ed.), *Insights in decision making: Theory and applications* (pp. 5-27). Chicago, IL: University of Chicago Press.

Slovic, P., Peters, E., Finucane, M. L., & MacGregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology*, *24*, S35-S40.

Suter, R. S., & Hertwig, R. (2011). Time and moral judgment. *Cognition*, *119*, 454-458.

Sütterlin, B., Brunner, T. A., & Opwis, K. (2008). Eye-tracking the cancellation and focus model for preference judgments. *Journal of Experimental Social Psychology, 44*, 904-911.

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

Tversky, A., & Kahneman, D. (1986). Rational choice and the framing of decisions. *Journal of Business*, S251-S278.

Tversky, A., Sattath, S., & Slovic, P. (1988). Contingent weighting in judgment and choice. *Psychological Review*, *95*, 371-384.

Venkatraman, V., Payne, J. W., & Huettel, S. A. (2014). An overall probability of winning heuristic for complex risky decisions: Choice and eye fixation evidence. *Organizational Behavior and Human Decision Processes*, *125*, 73-87.

Wedell, D. H. (1997). Another look at reasons for choosing and rejecting. *Memory & Cognition, 25*, 873-887.

Whyte, J., Cormier, E., & Pickett-Hauber, R. (2010). Cognitions associated with nurse performance: A comparison of concurrent and retrospective verbal reports of nurse performance in a simulated task environment. *International Journal of Nursing Studies*, *47*, 446-451.

APPENDICES

Appendix A

Table 1

The Frequency and Percent of Ratings in the Positive and Negative Rating Tasks for the Practice Question

Rating		1	2	3	4	5	6	7	8	9	10
Positive	Frequency	2	0	1	0	0	1	4	4	8	135
Rating	Percent	1.3	0.0	0.6	0.0	0.0	0.6	2.6	2.6	5.2	87.1
Negative	Frequency	79	5	3	0	2	3	3	1	1	48
Rating	percent	54.5	3.4	2.1	0.0	1.4	2.1	2.1	0.7	0.7	33.1

Appendix B

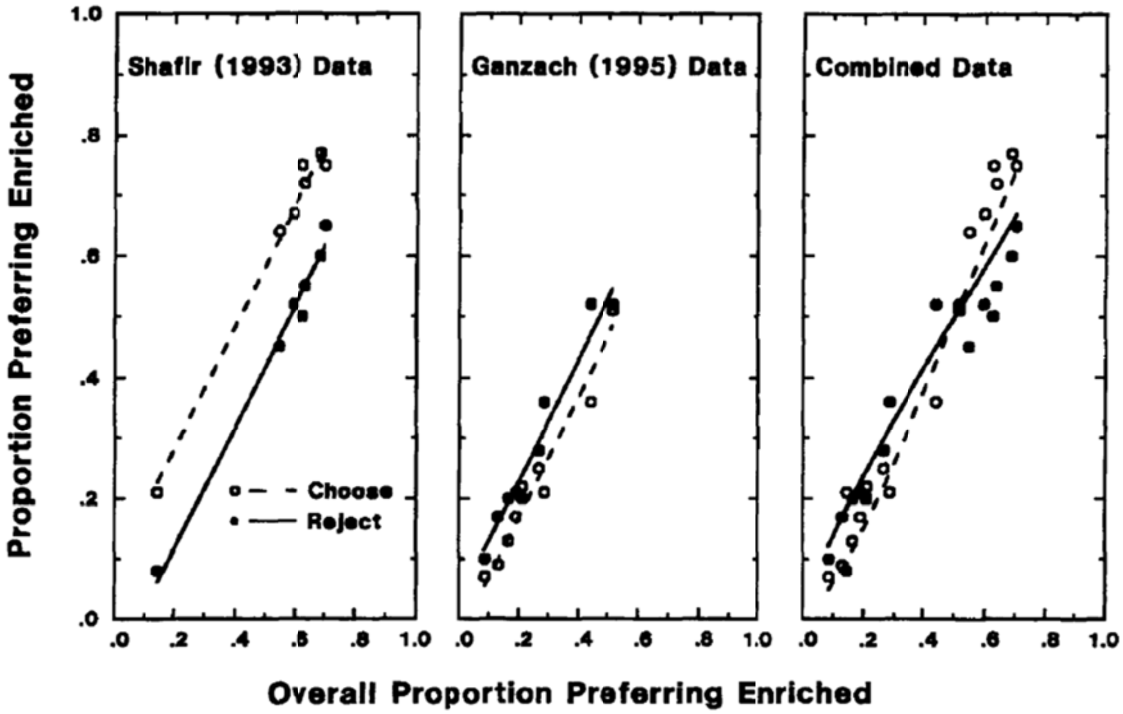


Figure 1. The left panel shows that in Shafir's (1993) data the enriched option was preferred more often in the selection task than in the rejection task; the middle panel shows that in Ganzach's (1995) data the enriched option was preferred less often in the selection task than in the rejection task; the right panel shows that the combined data of the previous study demonstrates the effect of relative attractiveness of the enriched option. Figure 1 from Wedell (1997).

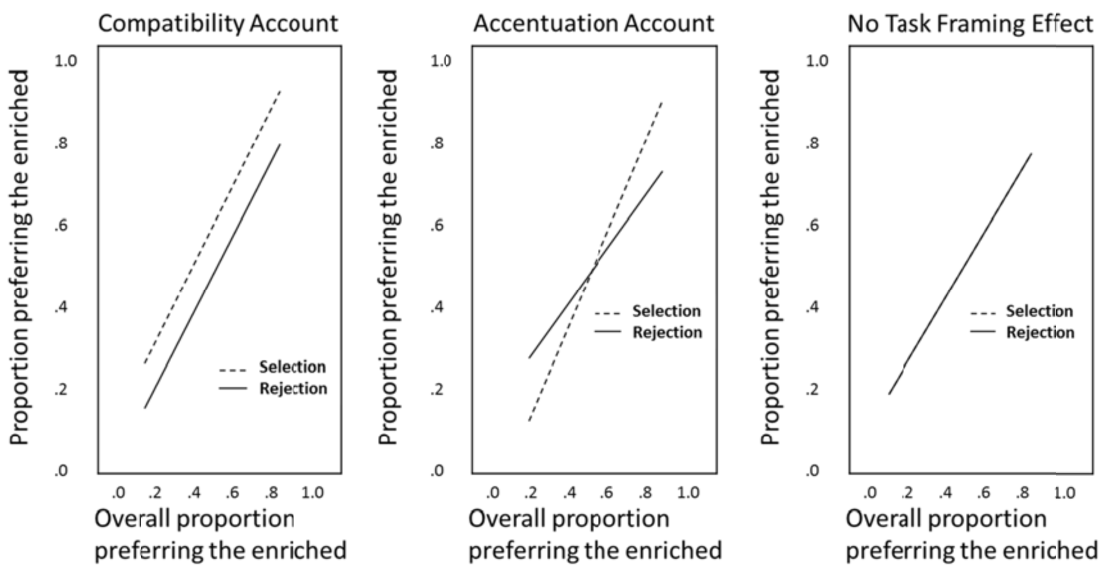
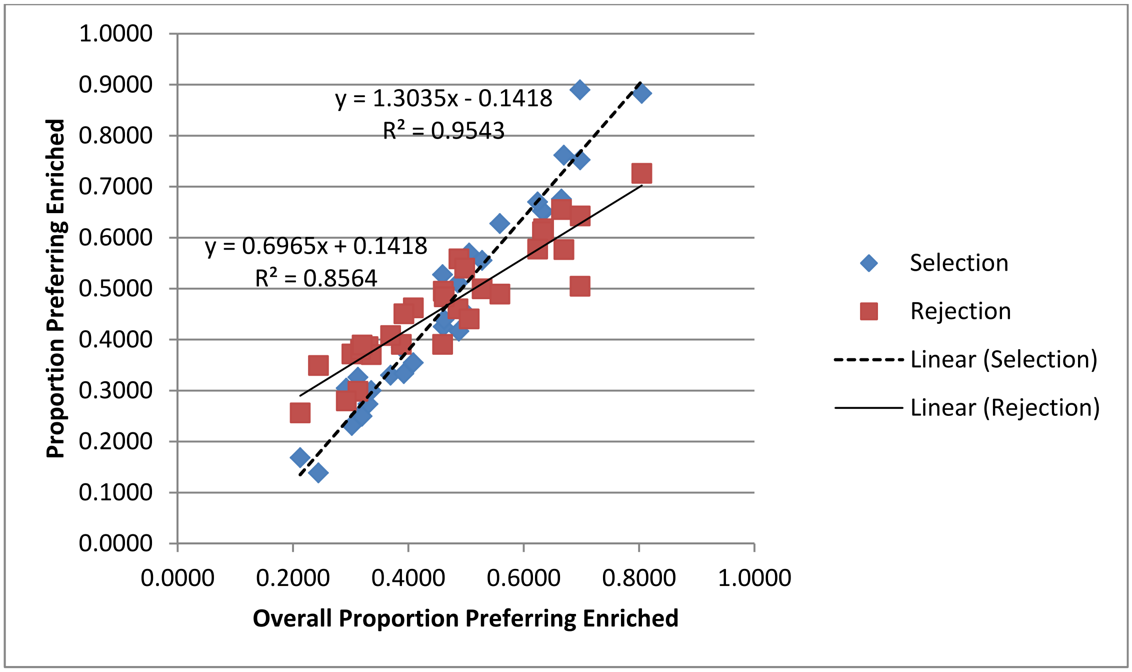


Figure 2. Result patterns predicted by the compatibility account (left panel), the accentuation account (middle panel), and the principle of procedural invariance (right panel).



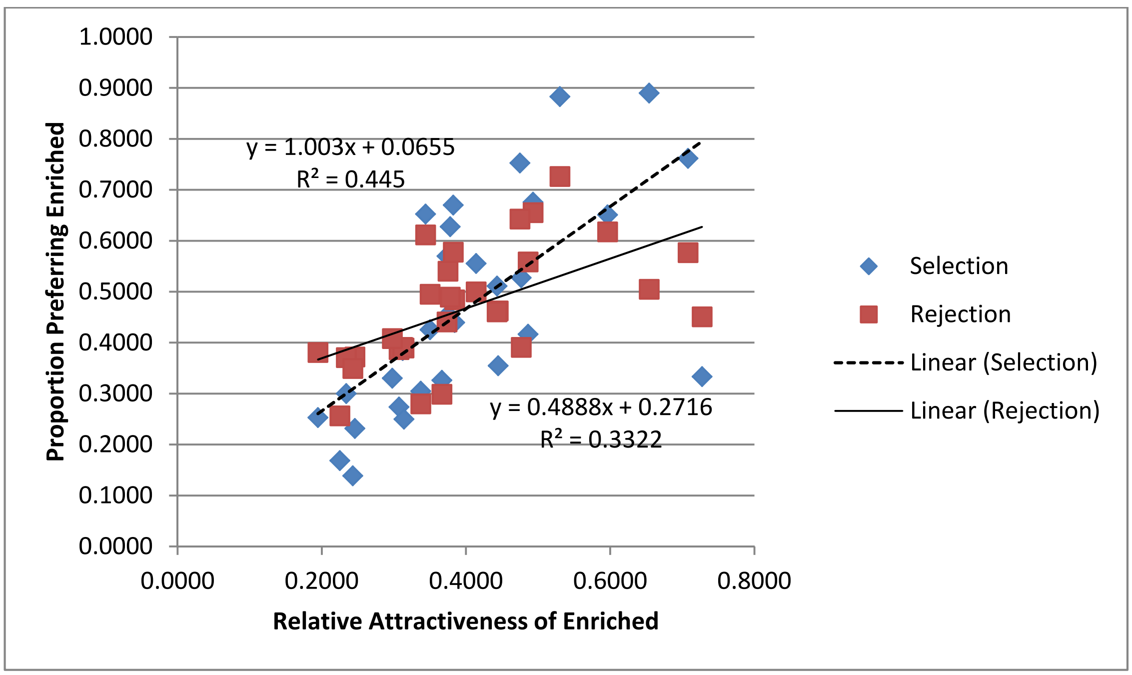


Figure 3. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for Sona participants in Experiment 1.

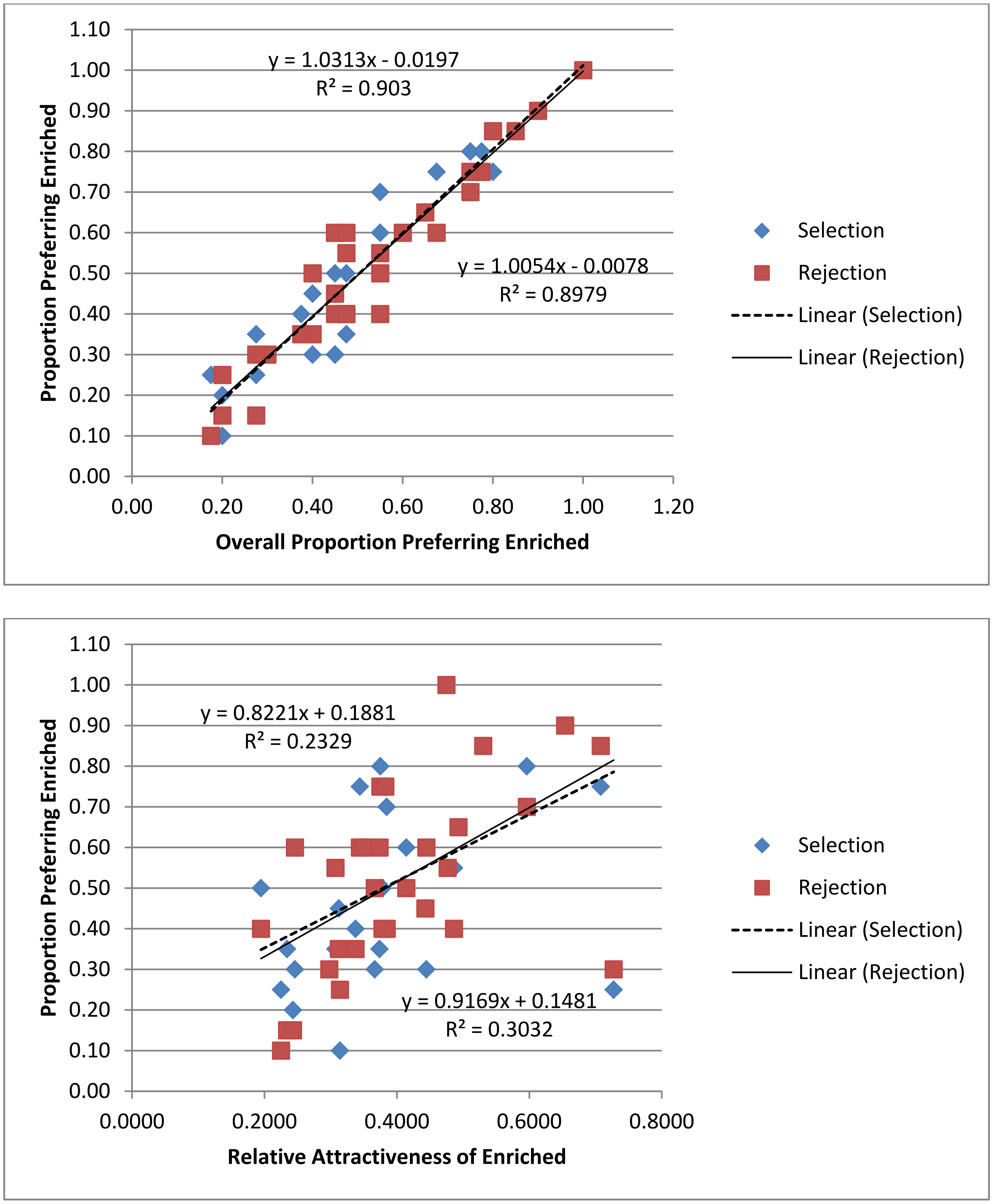


Figure 4. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for verbal-protocol participants in Experiment 2.

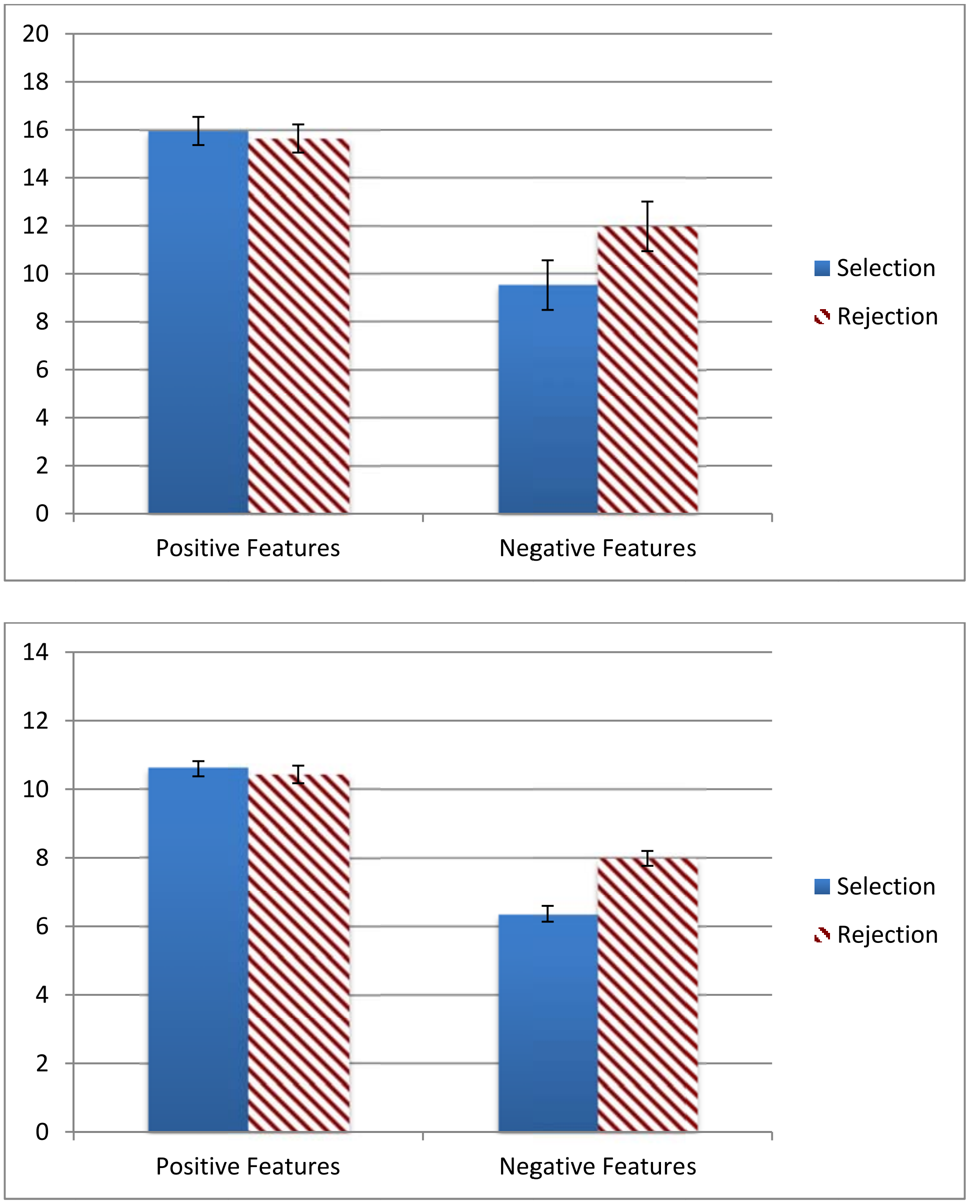
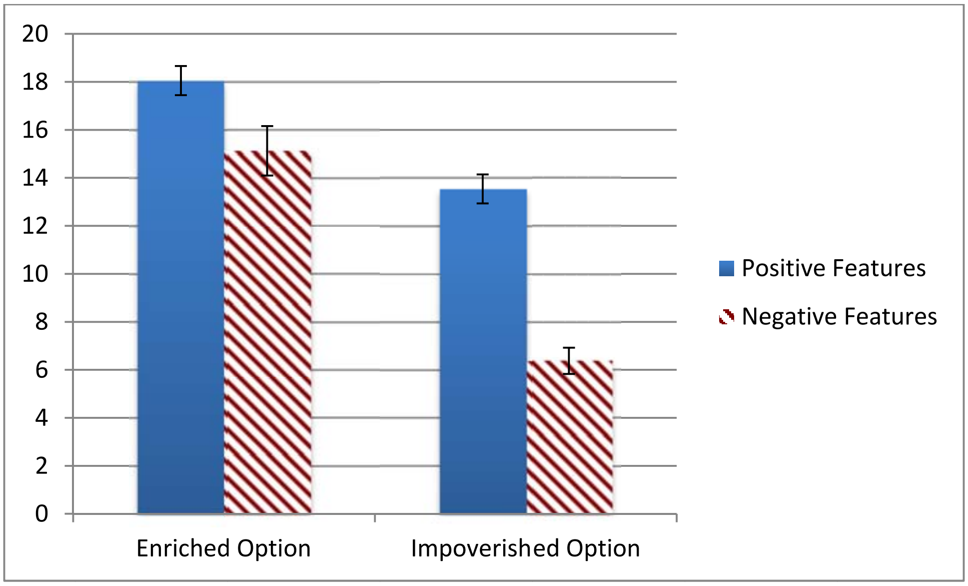


Figure 5. The frequency of the features being mentioned as a function of the valence of the features (positive vs. negative) and the task (selection vs. rejection). Top: Participant-based analysis; bottom: problem-based analysis. Error bars represent one standard error of the mean.



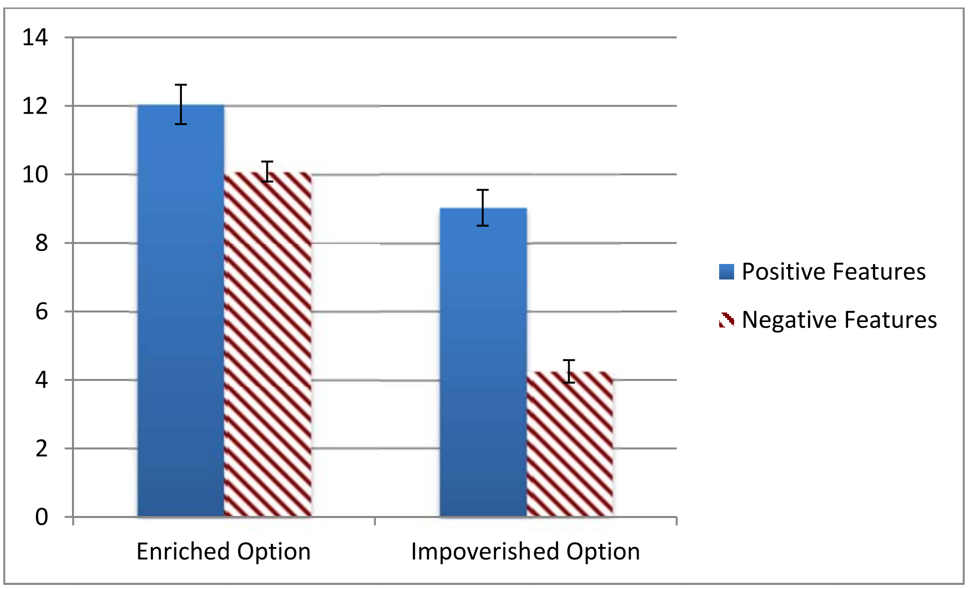


Figure 6. The frequency of the features being mentioned as a function of the valence of the features (positive vs. negative) and the task (selection vs. rejection). Top: Participant-based analysis; bottom: problem-based analysis. Error bars represent one standard error of the mean.

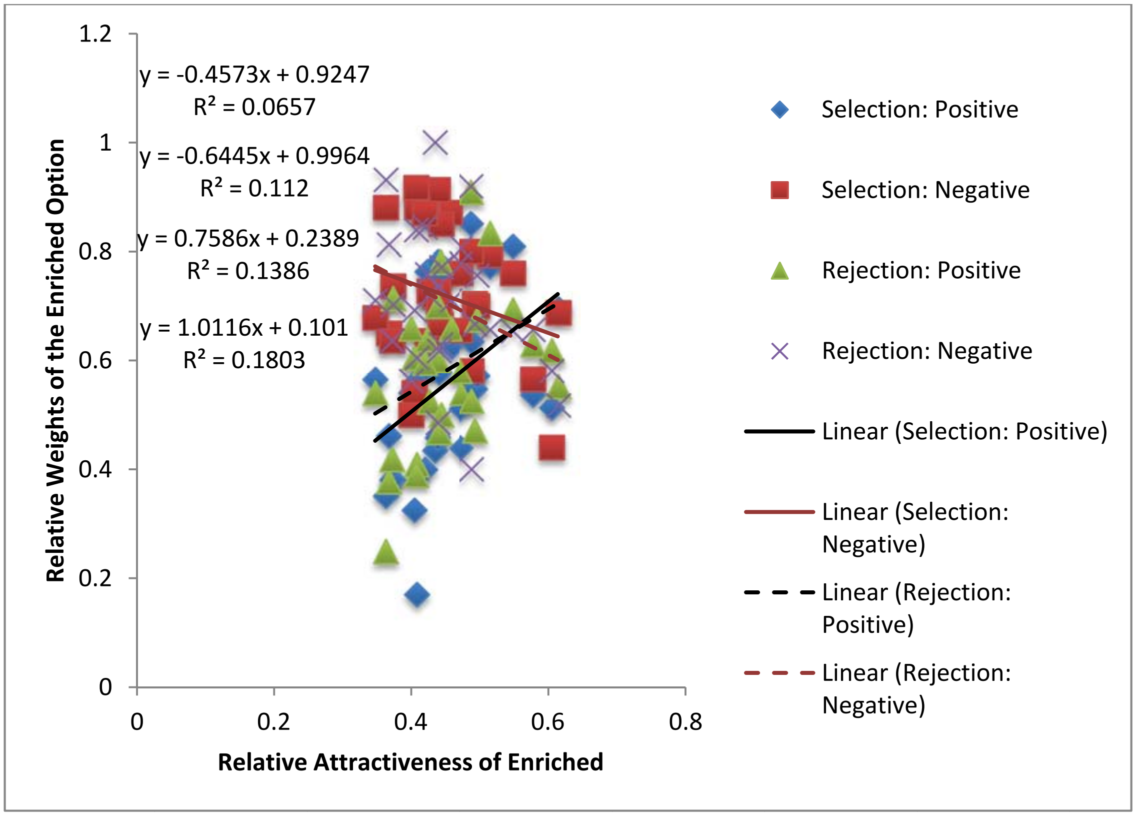
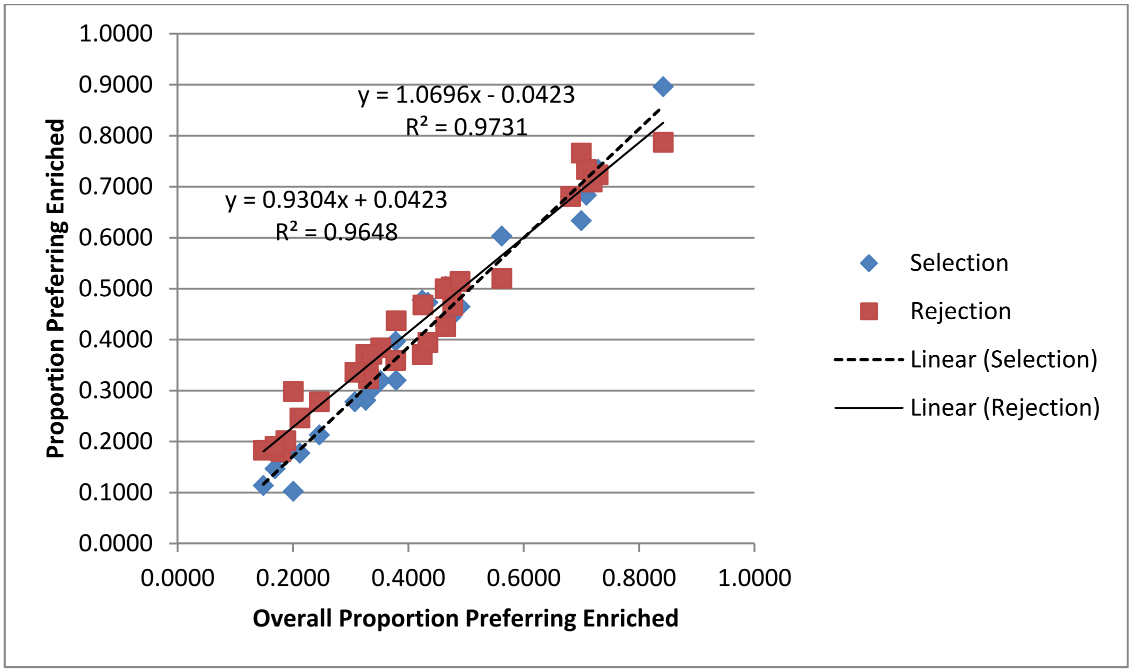


Figure 7. The relative weights of the positive and negative features being mentioned in the enriched option as a function of the relative attractiveness of the enriched option for the verbal protocols reports in Experiment 2.

Figure 8. The picture used on MTurk to require participants not to have participated in related experiments before.

Figure 9. Warning sign shown to participants if they clicked on the wrong option for the practice question.



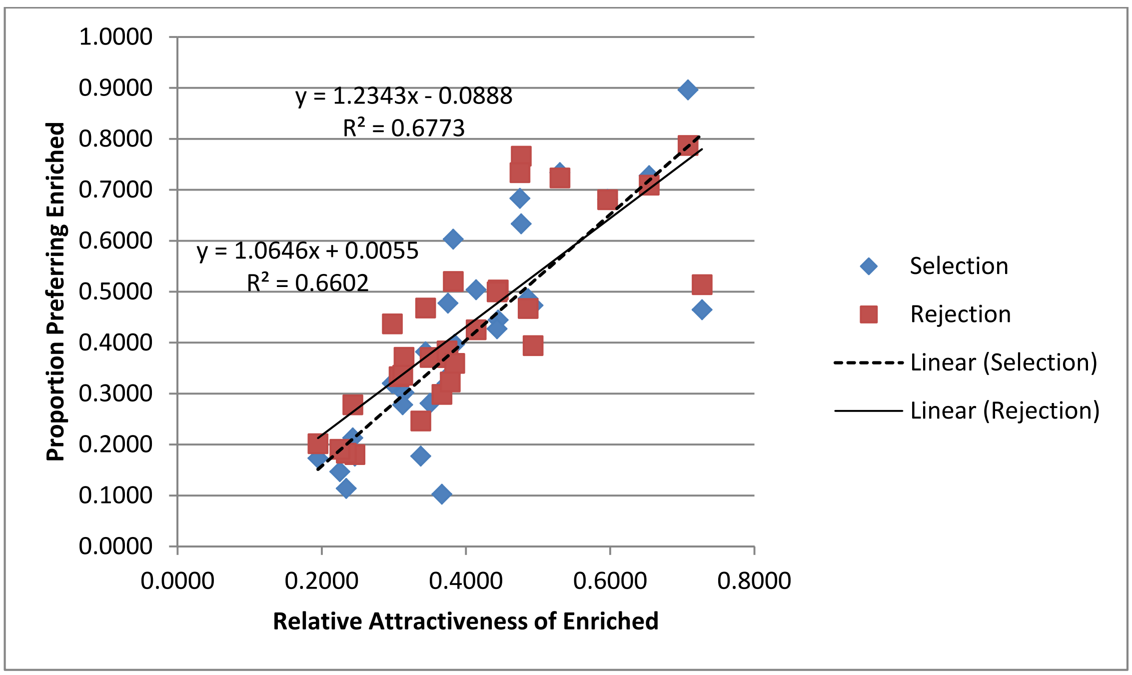
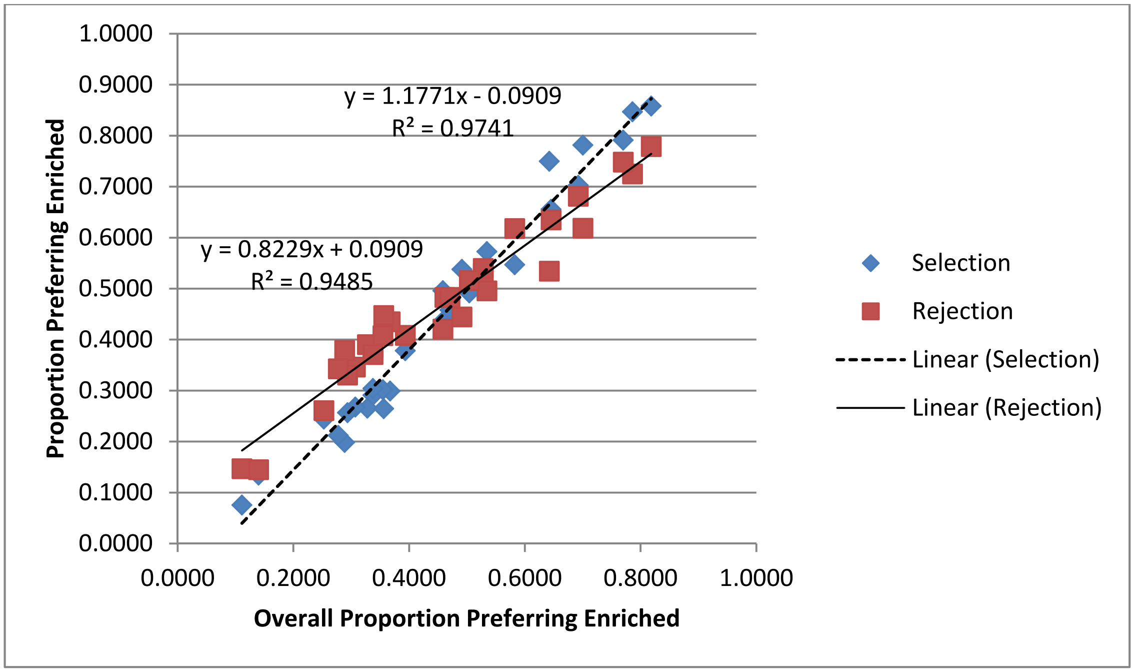


Figure 10. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for MTurk participants in Experiment 3.



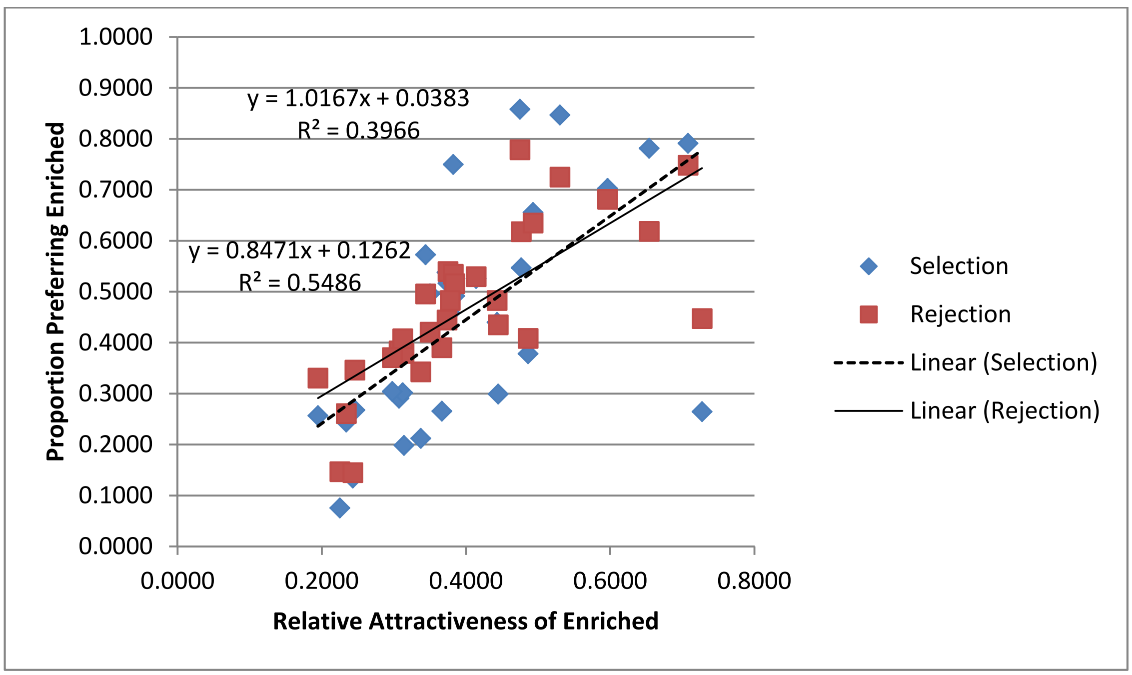
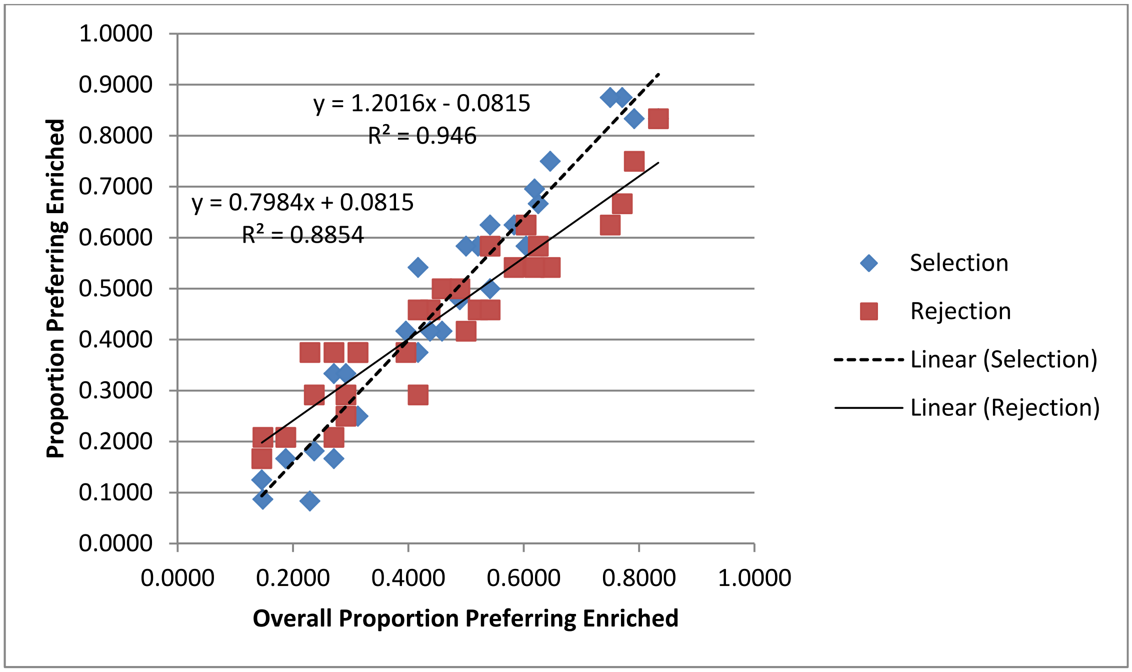


Figure 11. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for SONA participants in Experiment 3.



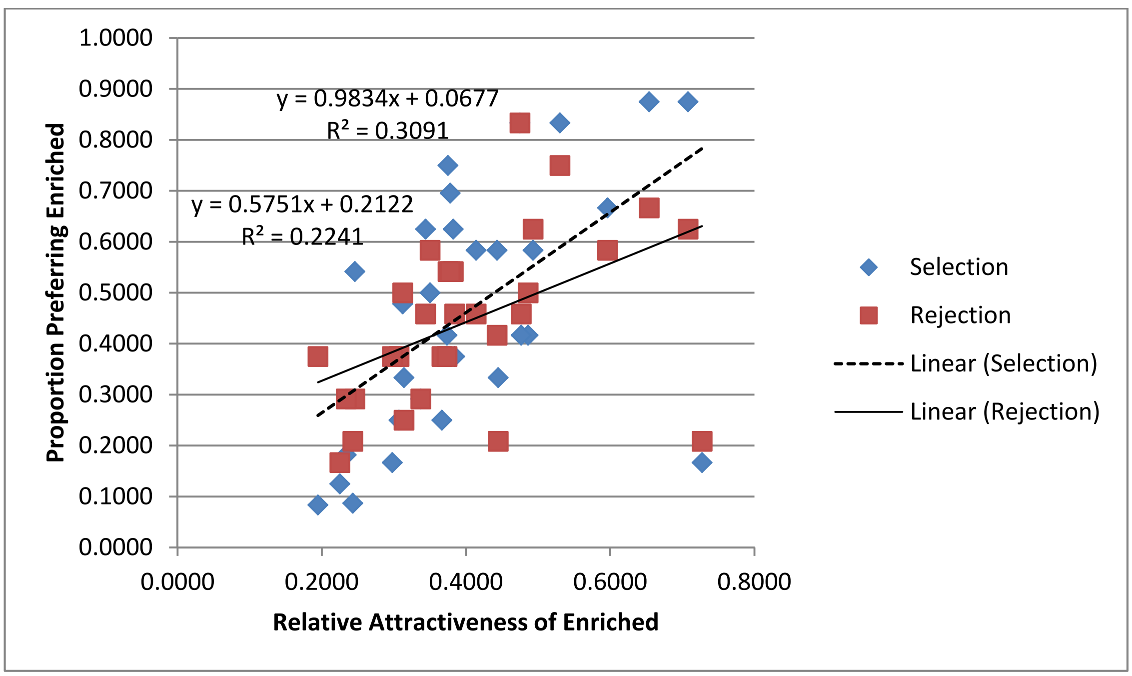
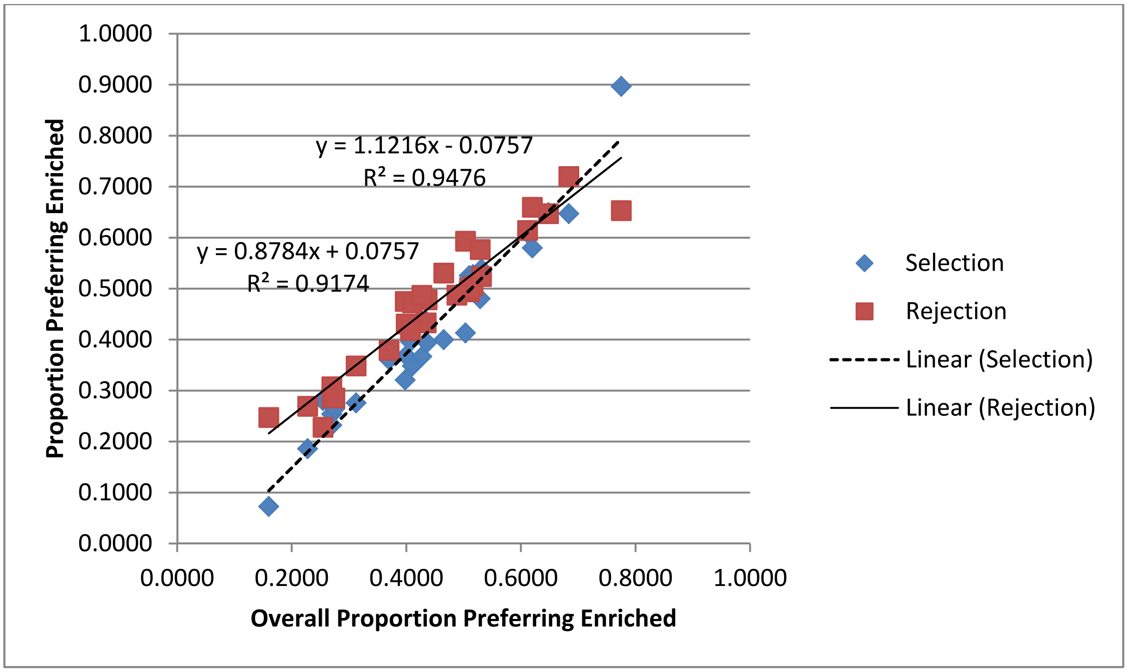


Figure 12. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for eye-tracking participants in Experiment 5.



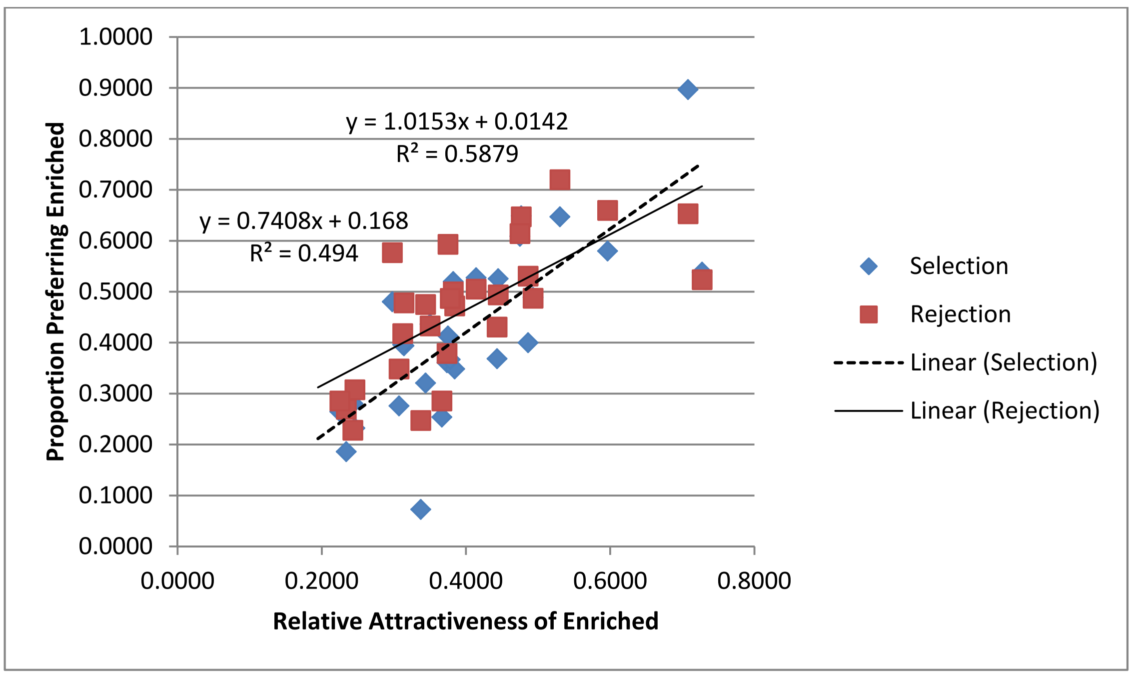
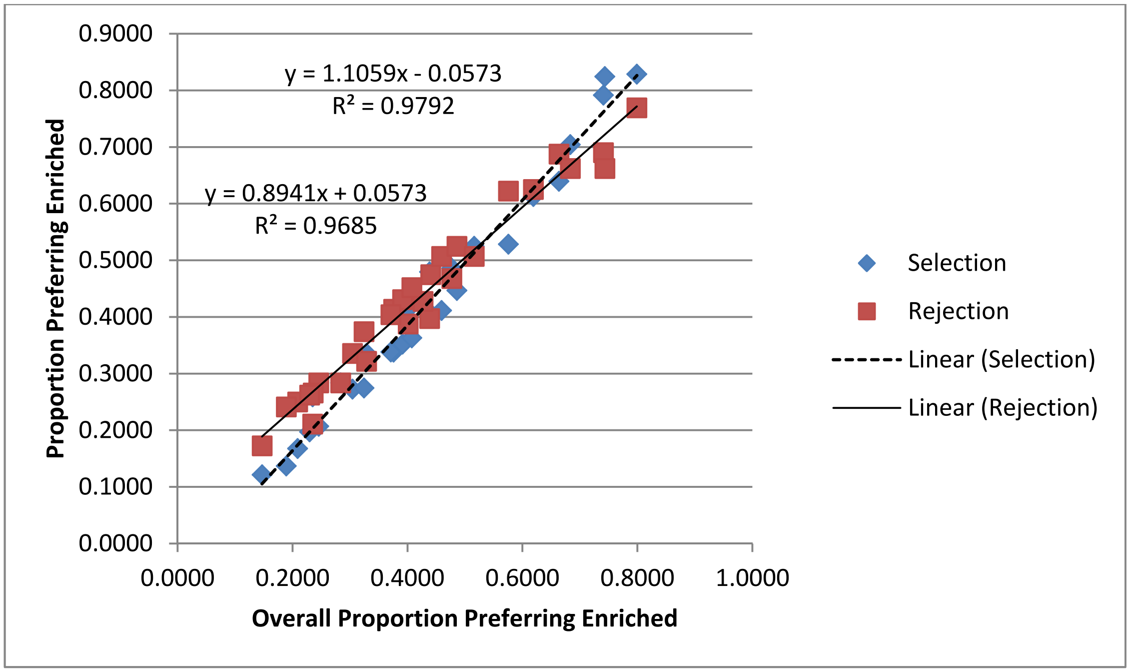


Figure 13. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for MTurk participants under time pressure in Experiment 6.



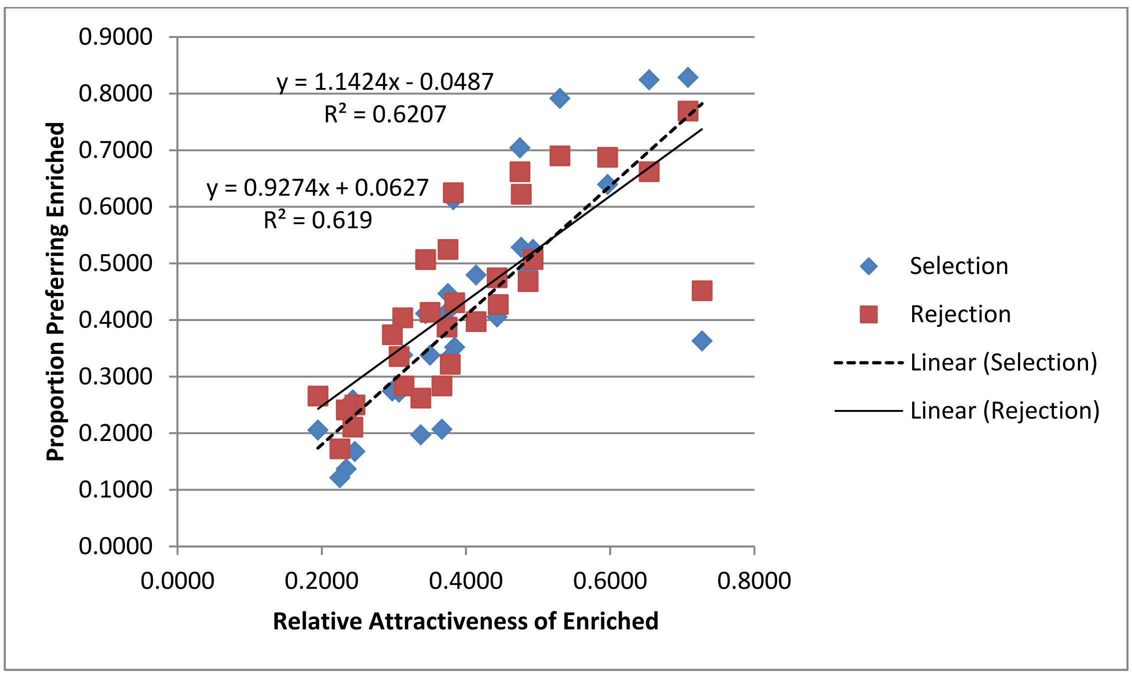


Figure 14. The proportions of the enriched option being preferred in selection and rejection tasks as a function of the overall proportion preferring the enriched option (top panel) and of the relative attractiveness rating of the enriched option (bottom panel) for MTurk participants with waiting time in Experiment 7.

Appendix C

Materials Used in the Experiments

The first 26 problems were taken from Wedell (1997). The last four problems were created similar to the gamble problems used in Shafir (1993).

Stimulus Topic	**Option Type**	**Description**
Child Custody	Enriched	Parent A has an above-average income, a very close relationship with the child, an extremely active social life, lots of work related travel, and minor health problems.
	Impoverished	Parent B has an average income, average health, average working hours, a reasonable rapport with the child, and a relatively stable social life.
Vacation	Enriched	Spot A has lots of sunshine, gorgeous beaches and coral reefs, an ultra modern hotel, cold water, and limited nightlife.
	Impoverished	Spot B has average weather, average beaches, a medium-quality hotel, medium-temperature water, and an average nightlife.

Election	Enriched	Candidate A served honorably as the vice president of the council last term. He organized a fund raiser to support the local children's hospital. He was voted "Most Intelligent" in high school. He enrolled as an art student in college, but dropped out. He has been divorced once.
	Impoverished	Candidate B enjoys camping and other outdoor activities. He is a local business man. In high school, he was voted "most enthusiastic." He majored in history in college. He has two children enrolled in the local elementary school.
Course	Enriched	Professor A is very enthusiastic and really gets excited about the course, is often very humorous, has you write two papers a week, is a hard grader but gives lots of useful feedback.
	Impoverished	Professor B is fairly interesting, speaks clearly, requires that you write one paper a week, and provides reasonable feedback.

Jobs 1	Enriched	Company A has a high starting salary, full health insurance coverage, a good vacation plan, limited opportunity for quick advancement, and has recently laid off some staff.
	Impoverished	Company B has an average starting salary, an adequate health insurance plan, a reasonable number of paid holidays, some opportunity for advancement, and a stable work environment.
Road Trip	Enriched	Vehicle A has abundant seating space, an excellent road-side assistance plan, free insurance coverage, a beat-up interior, and fairly poor gas mileage.
	Impoverished	Vehicle B has adequate seating space, average interior condition, moderate cost daily insurance, average gas mileage, and a limited road-side assistance plan.
Social Club	Enriched	Club A has a high rate of member participation, a variety of planned activities, requires only a small time commitment, has a low level of group cohesiveness, and participation in the different activities can get expensive.

	Impoverished	Club B has average member participation, average number of planned activities, moderate level of group cohesiveness, moderate amount of time commitment, and is affordable to join.
Apartment	Enriched	Apartment A has lower than average rent per month, located in a quiet community, all new, modern appliances, extended driving time to work due to traffic, and small bedrooms and closets.
	Impoverished	Apartment B has an average rent per month, moderate noise level from neighbors, adequate appliances, average driving time to work, and an adequate number of parking spaces available.
Ski Trip	Enriched	Ski resort A has fantastic powder snow, a free ski lesson, top quality rental skis, expensive lift tickets, and long lift lines.
	Impoverished	Ski spot B has average snow condition, average price lift ticket, rental skis of reasonable quality, average number of skiers, and moderate size ski slopes.

Restaurant	Enriched	Restaurant A has very exotic atmosphere, great tasting food, lots of different items on the menu, high prices, and long waits.
	Impoverished	Restaurant B has moderate atmosphere, ordinary food, average prices, fair service, and a variety of items on the menu.
Cars I	Enriched	Car A has a 36,000-mile bumper-to-bumper inclusive warranty, a high-performance engine, full option package, high insurance costs, and poorer than average gas mileage.
	Impoverished	Car B has a 36,000-mile warranty on major engine components, a standard engine, a standard option package, average gas mileage, and average insurance premiums.
Video Club	Enriched	Club A has a very wide selection, covers all of your favorite titles, very quick response to the newly released videos, high rental prices, and no bonus coupons.

	Impoverished	Club B has moderate variety of selections, decent rental prices, some titles of interest to you, fairly fast rental of new movie releases, and some bonus coupons from time to time.
Day Care	Enriched	Center A is close to your home and work, has a highly qualified staff, large class sizes, a tiny playground, is expensive, and requires participation in activities that are expensive.
	Impoverished	Center A is close to your home and work, has a highly qualified staff, large class sizes, a tiny playground, is expensive, and requires participation in activities that are expensive.
Health Club	Enriched	Club A has many modern weight machines, is open extended hours, provides sauna/pool privileges, is expensive, the exercise classes are crowded, and there are few trainers available for assistance.

	Impoverished	Club B has a moderate number of exercise classes, is competitively priced, has an average number of weight machines, is in a fairly modern building, has an average number of trainers available to assist you, and is open during regular business hours.
Cars 2	Enriched	Car A has many safety features and is fully "loaded," is very fuel efficient, requires high insurance premiums, and has little trunk space.
	Impoverished	Car B has an average number of safety features, is moderately fuel efficient and equipped with standard features, is of average size, and requires average insurance premiums.
House	Enriched	House A is in a very good neighborhood, is very large, is close to work/schools, has high property taxes, a small yard, and is in need of numerous repairs.
	Impoverished	House B is in an average neighborhood, has a medium-sized yard, is fairly close to your place of work, is average in size, and has average utility bills.

Concert	Enriched	Concert A has front-row seats, has three top bands, there is a very long wait to get into the arena, it is a long drive to get to the concert, and none of your friends are going.
	Impoverished	Concert B has average seats, the arena is a moderate distance from your home, some of your friends are attending, there is an average wait to get into the area, and has one top band.
Doctors	Enriched	Doctor A is very experienced and extremely well respected in the community, has an excellent "bedside manner," there is often a long wait in the waiting room, and the office is not convenient to your home and work.
	Impoverished	Doctor B has an average wait in the office, a good reputation in the community, an average "bedside manner," is a moderate distance from your home and work, and has had seven years in practice.

Jobs 2	Enriched	Offer A has a high salary, offers a long paid vacation each year in addition to holidays, has a very good benefit package, requires some overtime work, and has a moderately high stress level.
	Impoverished	Offer A has a high salary, offers a long paid vacation each year in addition to holidays, has a very good benefit package, requires some overtime work, and has a moderately high stress level.
Colognes	Enriched	Brand A has a unique, exquisite scent, is contained in a large bottle, comes in a box with a complimentary gift, is high in price, and the scent can sometimes make people sneeze.
	Impoverished	Brand B has a nice scent, is contained in an average size bottle, comes in a box, is moderately priced, and you have a normal reaction to the scent.
Vacations	Enriched	Option A is almost always sunny, offers a lot of cultural diversity, is nestled between the beach and mountains, has several added expenses, and is prone to high humidity

	Impoverished	Option B has a temperate climate, some culture diversity, average number of attractions, variety of overnight accommodations available, and is near a beach.
Dates	Enriched	Date A is honest, intelligent, seeks adventure, doesn't have much free time, and has a habit of being late.
	Impoverished	Date B has a nice personality, average sense of humor, is tall with brown hair, and has a college degree.
Universities	Enriched	University A has a beautiful campus, lower than average tuition, high job placement record, is located more than thirty miles from any substantial cities, has a reputation for difficult classes, and has a high first-year failure rate.
	Impoverished	University B has a reasonable tuition, average number of students per educator, offers a variety of degrees, and is a moderately sized campus that is located in a suitable area.

Shoes	Enriched	Pair A comes with a warrantee, they are highly stylish and match everything. However, they have a high price and they wear out quick.
	Impoverished	Pair B holds up okay, has an average price, no warrantee, they offer moderate support, and it appears as if everyone has a pair.
Toothpastes	Enriched	Brand A is tartar control formula, with baking soda and fluoride recommended by dentists. It comes in a no-mess stand-up tube, is expensive, and another customer tells you it doesn't have much flavor.
	Impoverished	Brand B has a mint flavor, an average price, contains fluoride, comes in a standard tube, and another customer claims to use it.
Computers	Enriched	Computer A has a 2-year warranty, extensive memory, is cheap, is rather slow in processing speed, and comes with almost no software.
	Impoverished	Computer A is moderately priced, has a 3-month warranty, reasonable memory, is midrange in speed, and comes with a standard package of software

Lottery 1	Enriched	You have a 60% chance to win $80, and a 40% chance to lose $10.
	Impoverished	You have a 20% chance to win $50, and otherwise nothing.
Lottery 2	Enriched	You have a 50% chance to win $80, and a 50% chance to lose $60.
	Impoverished	You have a 40% chance to win $60, otherwise nothing.
Lottery 3	Enriched	You have a 40% chance to win $10, and a 60% chance to lose $80.
	Impoverished	You have a 20% chance to lose $50, and otherwise nothing.
Lottery 4	Enriched	You have a 50% chance to win $60, and a 50% chance to lose $80.
	Impoverished	You have a 40% chance to lose $60, and otherwise nothing

Appendix D

Results on Subjective Ratings

Experiment 1

For satisfaction rating, there were main effects of feature order (*M*s = 7.74 vs. 7.51 for the positive-negative and negative-positive feature orders, respectively), $F(1, 29) = 32.16$, $p < .001$, $\eta_p^2 = .53$, and task frame (*M*s = 7.73 vs, 7.52 for selection and rejection tasks, respectively), $F(1, 29) = 14.38$, $p = .001$, $\eta_p^2 = .33$, and an interaction between the two factors, $F(1, 29) = 27.88$, $p < .001$, $\eta_p^2 = .49$. For positive-negative feature order, satisfaction rating was 7.94 for the selection task and 7.54 for the rejection task; for negative-positive feature order, satisfaction rating was 7.51 for both the selection and the rejection task.

For confidence rating, there were main effects of feature order (*M*s = 7.75 vs. 7.60), $F(1, 29) = 15.22$, $p = .001$, $\eta_p^2 = .34$, and task frame (*M*s = 7.82 vs. 7.54), $F(1, 29) = 34.26$, $p < .001$, $\eta_p^2 = .54$, and an interaction between the two factors, $F(1, 29) = 15.58$, $p < .001$, $\eta_p^2 = .35$. For positive-negative feature order, confidence rating was 7.97 for the selection task and 7.53 for the rejection task; for negative-positive feature order, confidence rating was 7.66 for the selection and 7.55 for the rejection task.

Experiment 2

Regarding the satisfaction rating, the main effects of task frame (*M*s = 8.16 vs. 8.53 for selection and rejection tasks, respectively), $F(1, 29) = 42.34$, $p < .001$, $\eta_p^2 = .59$, and feature order (*M*s = 8.22 vs. 8.47 for positive-negative and negative-positive feature orders, respectively) were significant, $F(1, 29) = 15.99$, $p < .001$, $\eta_p^2 = .36$, and the interaction between them was also significant, $F(1, 29) = 62.67$, $p < .001$, $\eta_p^2 = .68$.

Participants in the selection task had a higher rating when the negative features were presented above the positive features than the other way around (*M*s = 8.61vs. 7.70), whereas those in the rejection task rated their satisfaction higher when the positive features were presented above the negative features (*M*s = 8.74 vs. 8.34).

In terms of the confidence rating, the main effects of task frame (*M*s = 8.24 vs. 8.52 for selection and rejection tasks, respectively), $F(1, 29) = 14.56$, $p = .001$, $\eta_p^2 = .33$, and feature order (*M*s = 8.17 vs. 8.59 for positive-negative and negative-positive feature orders, respectively) were significant, $F(1, 29) = 34.17$, $p < .001$, $\eta_p^2 = .54$, and the interaction between them was also significant, $F(1, 29) = 46.89$, $p < .001$, $\eta_p^2 = .62$. Participants in the selection task had a higher rating when the negative features were presented above the positive features than the other way around (*M*s = 8.76 vs. 7.71), whereas those in the rejection task rated their confidence higher when the positive features were presented above the negative features (*M*s = 8.63 vs. 8.41).

Experiment 3A

For satisfaction rating, there significant factors were a main effect of feature order (*M*s = 8.07 vs. 7.99), $F(1, 29) = 6.03$, $p = .020$, $\eta_p^2 = .17$, and an interaction between feature order and task frame, $F(1, 29) = 8.38$, $p = .007$, $\eta_p^2 = .22$. For positive-negative feature order, satisfaction rating was 7.99 for the selection task and 8.15 for the rejection task; for negative-positive feature order, satisfaction rating was 8.00 for the selection and 7.98 for the rejection task. The main effect of task frame was not significant, $F(1, 29) = 1.45$, $p = .239$, $\eta_p^2 = .05$.

For confidence rating, the significant factors were a main effect of task frame (*M*s = 7.99 vs. 8.13), $F(1, 29) = 7.27$, $p = .012$, $\eta_p^2 = .20$, and an interaction between task frame and feature order, $F(1, 29) = 7.11$, $p = .012$, $\eta_p^2 = .20$. For positive-negative feature order, confidence rating was 7.99 for the selection task and 8.20 for the rejection task; for negative-positive feature order, confidence rating was 8.00 for the selection and 8.01 for the rejection task. The main effect of feature order was approaching the .05 significance level (*M*s = 8.00 vs. 7.60), $F(1, 29) = 4.08$, $p = .053$, $\eta_p^2 = .12$.

Experiment 3B

For satisfaction rating, a main effect of task frame (*M*s = 7.74 vs. 7.48 for the selection and rejection tasks, respectively) was the only significant factor, $F(1, 29) = 29.30$, $p < .001$, $\eta_p^2 = .50$. The main effect of feature order was not significant, $F(1, 29) = 0.45$, $p = .507$, $\eta_p^2 = .02$, nor was the interaction between the two, $F(1, 29) = 2.13$, $p = .155$, $\eta_p^2 = .07$. For confidence rating, there was again only a main effect of task frame (*M*s = 7.79 vs. 7.50 for the selection and rejection tasks, respectively), $F(1, 29) = 49.74$, $p < .001$, $\eta_p^2 = .63$. The main effect of feature order was not significant, $F(1, 29) = 0.24$, $p = .626$, $\eta_p^2 = .01$, neither was the interaction between the two, $F(1, 29) = 1.59$, $p = .218$, $\eta_p^2 = .05$.

Experiment 6

For satisfaction rating, only the interaction between feature order and task frame was significant, $F(1, 27) = 44.21$, $p < .001$, $\eta_p^2 = .62$. For positive-negative feature order, satisfaction rating was 6.94 for the selection task and 7.26 for the rejection task; for negative-positive feature order, satisfaction rating was 7.12 for the selection and 6.84 for the rejection task. The main effects of task frame, $F(1, 29) =$

0.06, p = .804, η_p^2 = .00, and feature order were not significant, $F(1, 27) = 3.10$, p = .090, η_p^2 = .10.

For confidence rating, there was an interaction between feature order and task frame, $F(1, 27) = 42.11$, $p < .001$, η_p^2 = .61. For positive-negative feature order, satisfaction rating was 6.79 for the selection task and 7.09 for the rejection task; for negative-positive feature order, satisfaction rating was 7.01 for the selection and 6.72 for the rejection task. The main effects of task frame, $F(1, 29) = 0.00$, p = .957, η_p^2 = .00, and feature order were not significant, $F(1, 27) = 1.37$, p = .253, η_p^2 = .05.

Experiment 7

For satisfaction and confidence ratings, the only effects that were approaching significance was for the confidence rating: the main effect of task frame (*M*s = 7.88 vs. 7.96 for selection and rejection tasks, respectively), $F(1, 29) = 3.77$, p = .062, η_p^2 = .12, and the interaction between feature order and task frame, $F(1, 29) = 3.51$, p = .071, η_p^2 = .11. For positive-negative feature order, confidence rating was 7.84 for the selection task and 7.99 for the rejection task; for negative-positive feature order, satisfaction rating was 7.92 for both tasks. No other effects approached the .05 level significance, *p*s > .100.

VITA

VITA

JING CHEN

Education

Ph.D., Cognitive Psychology 2015
Purdue University (anticipated)

M.S., Industrial Engineering 2015
Purdue University

M.Ed., Cognitive Psychology 2010
Zhejiang University

B.S., Psychology 2007
Zhejiang University

Honors and Awards

Women in CyberSecurity (WiCyS 2015) Student Scholarship (2015)
Purdue University Graduate School Fellowship Incentive Grant (2015)
American Psychological Association Dissertation Research Award (2014)
Purdue University Bilsland Dissertation Fellowship (2014−2015)
College of Health and Human Sciences Compton Graduate Research Travel Award (2014)
Human Factors and Ergonomics Society Student Author Presentation Support Award (2014)
Psychological Sciences Department Award for Graduate Research Innovation (2014)
Psychological Sciences Department Graduate Research Publication Award (2014)
Student Member with Honors of the Human Factors and Ergonomics Society (2013)
School of Industrial Engineering GSO Research Symposium Poster Contest (2013)
C. Eugene Walker Outstanding Graduate Student Department Award (2013)
Annual Computer Security Applications Conference Student Conferenceship (2012)
Purdue Graduate Student Government Travel Grant (2012)

Human Factors and Ergonomics Society COTG Student Travel Honorarium (2012)
Purdue University Frederick N. Andrews Fellowship (2010−2012)
Zhejiang University Chen Li Scholarship for Graduate Student (2009)
Triple A Graduate Student, Excellent Social Work Scholarship (2008)
Excellent Undergraduate Thesis of Zhejiang University (2007)
Excellent Graduate of Zhejiang Province (2007)
Zhejiang University Chen Li Scholarship for Undergraduate Student (2006)
Second-Class National Scholarship for Undergraduate (2004)
First-Class Excellent Academic Scholarship (2003−2006)

Peer Reviewed Journal Articles

Proctor, R. W. & **Chen, J.** (in press; invited paper). The role of human factors/ergonomics in the science of security: Decision making and action selection in cyberspace. *Human Factors.*

Yamaguchi, M., **Chen, J.**, & Proctor, R. W. (in press). Transfer of learning in choice reactions: The roles of stimulus type, response mode, and set-level compatibility. *Memory & Cognition.*

Chen, J., Gates, C., Li, N., & Proctor, R. W. (2015). Influence of risk/safety information framing on android app-selection decisions. *Journal of Cognitive Engineering and Decision Making, 9,* 149–168.

Chen, J., & Proctor, R. W. (2015). Influence of response-effect feedback on learning and performance of a complex key-pressing task: Morin and Grant (1955) revisited. *American Journal of Psychology*, *128*, 197-208.

Chen, J., & Proctor, R. W. (2014). Conceptual response distance and intervening keys distinguish action goals in the Stroop color-identification task. *Psychonomic Bulletin & Review*, *21*, 1238-1243.

Gates, C., **Chen, J.**, Li, N., & Proctor, R. W. (2014). Effective risk communication for Android Apps. *IEEE Transactions on Dependable and Secure Computing, 11*, 252-265.

Song, X., **Chen, J.**, & Proctor, R.W. (2014). Correspondence effects with torches: Grasping affordance or visual feature asymmetry? *Quarterly Journal of Experimental Psychology, 67*, 665-675.

Baroni, G., Yamaguchi, M., **Chen, J.**, & Proctor, R. W. (2013). Mechanisms underlying transfer of task-defined rules across feature dimensions. *Experimental Psychology*, *60*, 410-424.

Chen, J., & Proctor, R. W. (2013). Response-effect compatibility defines the natural scrolling direction. *Human Factors, 55,* 1112-1129.

Chen, J., & Proctor, R. W. (2012). Influence of category identity on letter matching: Conceptual penetration of visual processing or response competition? *Attention, Perception, & Psychophysics*, *74*, 716-729.

Proctor, R. W., & **Chen, J.** (2012). Dissociating influences of key and hand separation on the Stroop color-identification effect. *Acta Psychologica, 141*, 39-47.

Chen, J., Zhou, J., Cui, Y., & Shen, M. (2009). Visual masking effect depends on the perceived locations of objects. *Chinese Journal of Applied Psychology, 15*, 291-297.

Gao, Z., Shui, R., **Chen, J.**, Chen, W., Tian, Y., & Shen, M. (2009). The mechanism of negative numbers' spatial representation. *Acta Psychologica Sinica*, *41*, 95-102.

Shen, M., Shen, Y., Liang, J., Qiao, Y., **Chen, J.**, Chen, W., & Chen, S. (2008). IM usage experience and the model with usage motivation and preference. *Chinese Journal of Applied Psychology, 14*, 195-202.

Peer Reviewed Conference Proceedings

Jorgenson, Z., **Chen, J.**, Gates, C., Li, N., Yu, T., & Proctor, R. W. (2015). Understanding and communicating risk for mobile applications. In *Proceedings of Fifth ACM Conference on Data and Application Security and Privacy* (pp. 49-60). New York, NY: ACM.

Chen, J., Gates, C., Li, N., & Proctor, R. W. (2014). Framing of summary risk/safety information and app selection. In *Proceedings of the Human Factors and Ergonomics Society 58th Annual Meeting* (pp. 1461-1465). Santa Monica, CA: HFES.

Chen, J., & Proctor, R. W. (2012). Up or down: Directional stimulus-response compatibility and natural scrolling. In *Proceedings of the Human Factors and Ergonomics Society 56th Annual Meeting* (pp.1381-1385). Santa Monica, CA: HFES.

Gates, C., Li, N., **Chen, J.**, & Proctor, R. W. (2012). CodeShield: Towards personalized application whitelisting. In *Proceedings of the 28th Annual Computer Security Applications Conference* (pp. 279-288). New York, NY: ACM.

Conference Presentations

Chen, J., Yang, W., Xiong, A., Li, N., & Proctor, R. W. (2015). *Warning Users of Phishing Attacks with a Google Chrome Extension*. Talk presented at Human-Computer Interaction International 2015, Los Angeles, CA.

Proctor, R. W., **Chen, J.**, Gates, C., Li, N., Jorgensen, Z., & Yu, T. (2015). *Displaying Major Risks Factors Associated with Android Apps.* Talk presented at 6th International Conference on Applied Human Factors and Ergonomics, Las Vegas, NV.

Yang, W., **Chen, J.**, Xiong, A., Proctor, R. W., & Li, N. (2015). *Effectiveness of a Phishing Warning in Field Settings*. Poster presented at Symposium and Bootcamp on the Science of Security (HotSoS), Urbana, IL.

Chen, H., Chowdhury, O., **Chen, J.**, Li, N., & Proctor, R. W. (2015). *Towards Quantification of Firewall Policy Complexity*. Poster presented at Symposium and Bootcamp on the Science of Security (HotSoS), Urbana, IL.

Chen, J., Gates, C., Jorgensen, Z., Yang, W., Xiong, A., Li, N., Yu, & Proctor, R. W. (2015). *Effective Risk Communication for End Users: A Multi-granularity Approach*. Poster presented at the Women in CyberSecurity (WiCyS) Conference, Atlanta, GA.

Chen, J., Gates, C., Li, N., & Proctor, R. W. (2014). *Framing of Summary Risk/Safety Information and App Selection. T*alk presented at 58th Annual Meeting of the Human Factors and Ergonomics Society, Chicago, IL.

Chen, J., Gates, C., Li, N., & Proctor, R. W. (2014). *Effective Communication of Risks for Android Apps: Influence of Summary Risk Information and Framing.* Talk presented at 44th Annual Meeting of the Society for Computers in Psychology (SCiP), Long Beach, CA.

Chen, J., & Proctor, R. W. (2014). *Morin and Grant (1955) Revisited: Influence of Action-Effect Feedback on Learning.* Poster presented at 55th Annual Meeting of the Psychonomic Society, Long Beach, CA.

Chen, J., Gates, C., Li, N., & Proctor, R. W. (2014). *Decision Making in Android App Selection: Influence of Risk/Safety Framing.* Poster presented at 55th Annual Meeting of the Psychonomic Society, Long Beach, CA.

Chen, J., Song, X., & Proctor, R. W. (2013). *Grasping Affordance or Feature Asymmetry in Correspondence Effects for Flashlights.* Poster presented at 54th Annual Meeting of the Psychonomic Society, Toronto, Canada.

Chen, J., & Proctor, R. W. (2013). *Intuitive Design for Non-touch Screen Scrolling: Evidence from a Continuous Text-movement Task.* Paper presented at HCI International 2013, Las Vegas, NV.

Chen, J., Gates, C., Li, N., & Proctor, R. W. (2013). *Summary Risk Information Improves App Selection Decisions.* Poster presented at the IE GSO Symposium 2013.

Gates, C., & **Chen, J.** (presenter), Li, N., & Proctor, R. W. (2013). *Effective Risk Communication for Android Apps*. Poster presented at the CERIAS (Center for Education and Research in Information Assurance and Security) 2013 Symposium.

Chen, J., & Proctor, R. W. (2012). *Up or Down: Directional Stimulus-Response Compatibility and Natural Scrolling.* Talk given at 56th Annual Meeting of the Human Factors and Ergonomics Society, Boston, MA.

Chen, J., & Proctor, R. W. (2012). *A Conceptual Response-Distance Effect for the Stroop Task.* Poster presented at 53rd Annual Meeting of the Psychonomic Society, Minneapolis, IN.

Chen, J., & Proctor, R. W. (2012). *Key Distance not Hand Distance Influences the Stroop Color-Identification Effect.* Poster presented at 24th Annual Meeting of the Association for Psychological Science, Chicago, IL.

Chen, J., & Proctor, R. W. (2012). *The Response Distance Effect in the Stroop Color-Identification Task: Key or Hand Separation?* Poster presented at Midwest Cognitive Science Conference, Bloomington, IN.

Chen, J., & Proctor, R. W. (2011). *Influence of Name-Identity on Physical same-Different Letter Matching.* Poster presented at 52nd Annual Meeting of the Psychonomic Society, Seattle, WA.

Chen, J. (2008). *A Review of Psychological Distance and Construal Level Theory*. Paper presented at 4th Academic Conference of Graduate Students in the Department of Psychology. Hangzhou, China.

Teaching Experience

Supervised Undergraduate Research, 32 students — 2010-2015

Human Factors in Engineering (PSY/IE 577) — Spring 2012
Teaching Assistant (gave 1 lecture)
Instructor: Dr. Robert W. Proctor

Human Factors in Engineering (PSY/IE 577) — Fall 2011
Teaching Assistant (gave 2 lectures)
Instructor: Dr. Robert W. Proctor

Introduction to Cognitive Psychology (PSY 200) — Spring 2011
Teaching Assistant
Instructor: Dr. Gregory Francis

Human Factors in Engineering (PSY/IE 577) — Fall 2010
Teaching Assistant
Instructor: Dr. Robert W. Proctor

Professional Memberships

American Psychological Association
Student member; Divisions 3 & 21 member
Human Factors and Ergonomics Society
Student member; 2012 & 2014 annual meeting student volunteer
HFES Purdue Student Chapter
Student member; Communication Director, 2012−2014
Association for Psychological Science
Student member; Campus Representative, 2012−present

Ad hoc Reviews

American Journal of Psychology
Journal of Cognitive Psychology
Chinese Science Bulletin

Media Coverage

Research featured by *National Science Foundation (NSF) Discoveries*

- **Experts identify easy way to improve smartphone security**
- http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=133144