Does Attention Confer Importance? Examining Evidence from the Multiattribute Choice Domain

Anirudh Tiwathia (atiwathia@uchicago.edu)
Division of the Social Sciences and the Harris School of Public Policy Studies, University of Chicago
245 E. 40th St. Apt 25F, New York, NY 10016 USA

William M. Goldstein (gold@uchicago.edu)
Departments of Psychology and Comparative Human Development, University of Chicago
5848 South University Avenue, Chicago, IL 60637 USA

Abstract

There is a prevalent claim in the judgment and decision making (JDM) literature that attention to a piece of information confers weight or importance upon that information. The prevalence of that claim is not commensurate with the empirical evidence – the quantity of evidence is sparse, and, is constrained by significant limitations in the methodological approach of previous studies. The current work presents a novel method for covertly manipulating attention to different components of a decision scenario. Using this approach, the current work provides empirical evidence from three multiattribute scenarios in support of a consistent, positive causal relationship between the attention allocated to a piece of information and the influence accorded to it. In addition, the current work demonstrates the viability of crowdsourcing psychological research, including research that involves significant perceptual components.

Keywords: attention; weight; importance; multiattribute choice; working memory; crowdsourcing; Amazon's Mechanical Turk.

Introduction

When deciding between two or more options, one must determine how much importance to place on the different attributes that define each option. For example, when choosing between two cars with different price and mileage, one must know how much relative importance to give to each of the two attributes. This everyday notion of *importance* has been incorporated into models of choice through the notion of *decision weight*. In the broadest sense, decision weight represents the amount of influence that the attribute value has in the evaluation of a particular option.

There is a prevalent trend in the literature that postulates an intimate relationship between decision weight and attention (e.g. Busemeyer & Johnson, 2008; Weber & Kirsner, 1997). Frequently, attention is claimed to bestow importance upon the variable under consideration. For example, while discussing *de-biasing* effects, Kahneman & Frederick (2002) claim that "the weight of neglected variables can be increased by drawing attention to them." Similarly, Carmon & Ariely (2000) draw upon the same premise to propose an attention-based explanation for differences in willingness-to-pay and willingness-to-accept. While attention to a piece of information is likely to be a *necessary* condition for that information to influence decision-making, there is inadequate empirical evidence to support the claim that attention is a *sufficient* condition for determining the influence attached to a piece of information. Some authors have argued that the effect of attention may depend on characteristics of the attended attribute, such as evaluability (Bertini & Wathieu, 2008), relevance to decision at hand (Bastardi & Shafir, 1998), or even the motivational predispositions of decision maker (Sherman et al., 2005).

Crucially, however, these studies suffer from substantial methodological limitations. Most manipulate attention through indirect techniques such as asking the decision maker to adopt different roles (e.g. as cited in Kahneman & Frederick, 2002), timing of information (Bastardi & Shafir, 1998), price splitting (Bertini & Wathieu, 2008), or font-size (Weber & Kirsner, 1997). As such, these studies face difficulties separating the effects of attention from other effects (e.g. larger font may yield demand effects, since large font is customarily associated with more importance).

The current empirical evidence does not support conclusions regarding the causal relationship between attentional allocation and weight. Given that attention is deeply embedded in cognitive theories of decision-making and psychologically-plausible conceptions of weight, the relationship between attention and weight needs to be carefully examined (Weber & Johnson, 2009).

Experimental Overview

The current study aims to examine whether attentional allocation causally modifies the weight associated with an attribute. To do so, we introduce a novel method for covertly manipulating the attention of the decision-maker. Using this method, we can systematically measure the effect of attentional allocation on choice, and thus, we can infer the effect of attentional allocation on attribute weight.

Covert Manipulation of Attention

To covertly manipulate the decision-maker's attention, the current design used a spatial working memory task. Working memory (WM) and selective attention show behavioral, functional, and neural overlap (Soto et al., 2008). The contents of WM guide the allocation of attention (Downing, 2000) under a broad set of scenarios, including conditions where it is disruptive to the primary task; when there is a long interval between the WM prompt and the search display; when the WM stimulus is encoded verbally; and when the WM stimulus shares only a semantic relationship to the probe display items (Soto et al., 2008).

Based upon such results, WM is conceptualized by some researchers as attention-based rehearsal (for a review, see Awh, Vogel, & Oh, 2006). Spatial WM, in particular, may be maintained by means of covert shifts of spatial attention to the memorized locations (Awh & Jonides, 2001; Theeuwes, Belopolsky, & Olivers, 2009). In addition, memorized locations can behave like attended locations and show enhanced visual processing (Awh et al., 1998).

These findings suggest that a spatial working memory task can be used to direct participant attention to a specified location. Thus, it provides a method to systematically direct attention to specific components of a decision problem.

Based on this premise, the present work employed a dual-task paradigm: (a) a spatial WM task, and (b) a multiattribute-decision problem. First, participants memorized a location on screen. Then, they solved a multi-attribute choice problem. Since the participants solve the decision problem while keeping the location in WM, the memorized location should receive additional attention while they are engaged in the decision problem. If so, we can systematically direct the participant's attention to specific components of a decision problem by selecting a to-be-memorized location that overlaps with the target information.

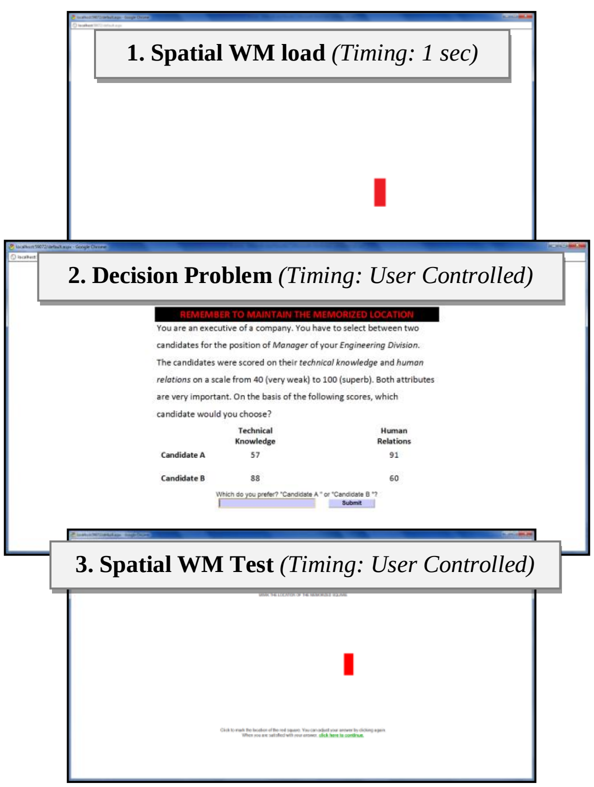

Figure 1. The participants had to sustain the memorized location in WM while making their choice.

Stimuli and Procedures

The current work has a 3 (Question: Q1 – Q3) x 2 (Attention: Attribute 1 / 2) between-subjects design.

Stimuli Order Each participant was presented stimuli in the following order: (1) Spatial WM load; (2) Decision problem; (3) Spatial WM test; (4) Surprise recall test; (5) Debriefing questions. See Figure 1.

All stimuli were presented in an 800 x 500 pixel frame. The location to be memorized was indicated by a red rectangle (35 x 92 px) that appears on a white background for 1 second. After the red square, there was a 250ms onset delay before the decision problem was presented on screen.

The decision problem was on screen for a minimum of 8 seconds before the participant could submit an answer and progress to the next page. However, participants on average spent about 50 seconds per question, thereby demonstrating a healthy degree of engagement with the problem scenarios.

After submitting their answer, participants were asked to click on screen to mark the memorized location. Clicking on screen caused a red rectangle – identical to the original – to be centered at the site of the click as a visual aid. Participants could continue to modify their answer until satisfied. They spent an average of 15 seconds doing so, suggesting a healthy engagement with the memory task.

Attentional Manipulation The decision questions (Q1 – Q3) were presented such that the attribute values for both options appeared in columns. Participants were randomly assigned to one of two attentional manipulation conditions: either the memorized location overlapped with the value column of Attribute 1 or it overlapped with the value column of Attribute 2. See Figure 2.

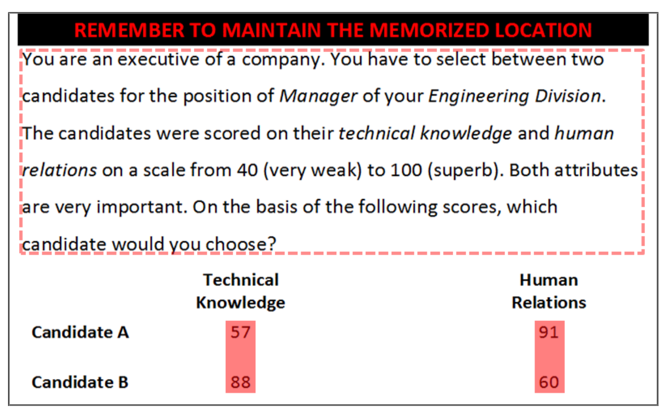

Figure 2. The two transparent rectangles show the position of the box in the Attribute 1 and 2 conditions.[1]

Dependent Variables For each participant and condition, the primary variables of interest are the stated choice itself and the performance on the spatial memory task.

[1] The red box is never on screen at the same time as the question. It appears in both locations here only to facilitate visualization of the attentional manipulation.

Performance on the memory task was measured as the total number of pixels between the centers of the original location and the remembered location.

Data Collection and Analysis

Data for the current studies were collected using a *crowdsourcing* platform called Amazon's Mechanical Turk (AMT). AMT is an online service through which *workers* and *requesters* can engage in micro-contracts, where the worker completes a micro-task for the *requester* in exchange for some predetermined wage.

AMT as an Experimental Platform AMT provides a largely untapped and easy-to-reach subject pool. According to a recent demographic survey, *workers* were primarily from America (47%) and India (34%) (see, Paolacci, Chandler, & Ipeirotis, 2010 for details). Paolacci et al. found no significant differences in the pattern of choices for classic judgment and decision making (JDM) problems (e.g. Asian Disease Problem, or Linda Problem) between subjects drawn from (a) AMT, (b) internet forums, and (c) a US university. Horton, Rand, & Zeckhauser (2010) also replicated classic findings using AMT, such as the framing effect; pro-social preferences in prisoner's dilemma games, and priming effects on choice behavior. Both Paolacci et al. (2010) and Horton et al. (2010) concluded that online labor markets are more representative than traditional university subject pools and have potential as experimental platforms. It is beyond the scope of this paper to fully evaluate the merits and drawbacks of utilizing AMT as an avenue for research (see, Paolacci et al., 2010 and, especially, Horton et al., 2010). The data presented in the above-mentioned papers, as well as the growing interest in such tools, do, however, bolster the methodology used here.

Data Validity

Due to the limited accountability afforded by AMT and the low English proficiency of many participants, a significant portion of the data was below acceptable standards, thereby requiring a systematic data screening process. Based on pilot data from 300+ participants, a series of precautions and data verification measures were developed to allow a measure of task engagement and to systematically mitigate data validity concerns.

For the current study, a total of 227 participants were recruited using AMT. Participants came from 32 countries, with the majority from the US (45%) and India (38%). The following section describes each of the catch mechanism, and lists the number of participants excluded based on each criterion.[2]

Methodological Precautions

Unlike the AMT studies discussed earlier (Paolacci et al., 2010; Horton et al., 2010), the current design involved perceptual components, which pose a particular challenge to online experimentation. One difficulty comes from the significant variation in user's screen sizes and resolutions. To minimize any unintended effects resulting from this variability, the study was presented in an *iframe*[3]. Additionally, the study was launched in a new window that automatically covered the entire monitor at the onset. The window and monitor size was measured at the beginning and the end of the study. Participants were disqualified if they changed the window size. The back-button on the participant's browser was disabled and tracking variables were used to prevent participants from cheating on the recall questions by re-visiting the previous screen or restarting the study. Further, the mouse cursor was hidden during the memory test so participants could not use it to mark the memorized location.

Catch Mechanisms and Exclusion Criteria

In addition to the precautions described above, the current design included several "catch mechanisms" to identify the participants who were either "cheating" or not actively engaged with the task. A total of 78 participants were excluded; the distribution across criteria is detailed below.

Spatial Memory Task In the current design, successful attentional manipulation depended upon the participants' engagement with the spatial WM task. With this in mind, the data set was restricted to those participants whose total error was less than two standard deviations above mean (i.e. error < Avg. + 2 SD). A total of 16 participants were excluded based upon this criterion.

Question Time The time spent on each portion of the study was recorded. On average, participants spent 50 seconds reviewing the problem. Participants who spent less than 15 seconds were excluded; a total of 4 fell under this criterion.

Numerical Recall Participants were given a surprise recall test asking them to list the four numbers that comprised the two options of the decision problem. Participants were excluded if they could not recall at least three of the four numbers presented on screen. The participant response was coded as acceptable if it was ± 5 from the actual value. The use of a range was based on the idea that participants may encode and recall the gist, rather than the specific value. A total of 24 participants were excluded under this criterion.

Problem and Reason Recall As part of the surprise recall test, participants were asked to restate the problem scenario and give a reason for their choice. This was intended as a basic comprehension test. Responses were entered as free text. To avoid any inadvertent biases, both fields were analyzed by a coder who was blind to the participant's

[2] So as to avoid double counting, participants who violated two or more exclusion criteria are only listed once.

[3] By using an iframe, the presentation space does not vary with the size of browser window or the screen resolution of the computer. Thus, participants with larger monitors would have a larger white background framing the presentation space.

attentional manipulation condition. Participants were excluded only if they showed little or no evidence of problem comprehension or engagement. Eighteen participants were excluded under this criterion.

Demand Effects Participants were asked three funneled questions to determine if they were aware of the experimental manipulation. The most general one asked if participants saw "a connection between the two tasks" The narrower question asked if they thought the memory task had changed their choice. Finally, the most pointed question asked if the specific location of the rectangle had any effect on their answer to the problem. Almost all participants remained entirely unaware of the true intentions of the experimental manipulation. However, three did correctly identify the purpose of the attentional manipulation; their data were excluded to avoid concerns about demand effects.

Self-Report As a final methodology check, participants were asked if they had used any tricks or strategies to complete the task. They were clearly informed that they would not be penalized for revealing them. Thirteen participants admitted to using their fingers to mark the memorized location on screen; data for those 13 participants were excluded from further analysis.

Results

Question 1: Choosing Among Cars

Participants were asked to choose between two cars rated on their safety and performance. The attribute values for each option were mirrored such that the safety rating for Car A was equal to the performance rating for Car B (shifted by 3 to occlude the mirroring), and vice versa. Car A was superior on performance and Car B was superior on Safety. For notational convenience, we will hereon refer to them as the *Performance* and *Safety cars* respectively.

> You wish to buy a new car. You have narrowed the choice to the two cars listed below. Both cars cost the same. Each car is rated on safety and performance using an industry-wide rating scale ranging 0 (worst) – 100 (best). Based on the ratings, which car would you buy?

	Safety	Performance
Car A	73	91
Car B	88	76

Effect of Attentional Manipulation The attribute values displayed at the memorized location had an increased influence on final choice. Participants who had the memorized location overlap with the column of safety values (73; 88) were more likely to select the *safety car* than participants who had the memorized location overlap with the performance values (91; 76), and vice versa; χ^2 (1, N = 57) = 3, p = 0.042 (one-tailed). See Table 1.

Table 1: Effect of Attentional Focus on Choice of Car

[N = 57]	Safety Car	Performance Car
Attention to Performance Ratings	11 (48%)	12 (52%)
Attention to Safety Ratings	24 (71%)	10 (29%)

Question 2: Production Engineer

The following scenario was replicated from Tversky, Sattath, & Slovic (1988).

> You are an executive of a company. You have to select between two candidates for the position of a Production Engineer. The candidates were scored on their technical knowledge and human relations on a scale from 40 (very weak) to 100 (superb). Both attributes are important, but technical knowledge is slightly more important than human relations. On the basis of the following scores, which candidate would you choose?

	Technical Knowledge	Human Relations
Candidate A	86	76
Candidate B	78	91

Candidate A was superior on Technical Knowledge, while Candidate B was superior on Human Relations; for notational convenience, we refer to them as the *Technical Candidate* and *Sociable Candidate* respectively.

Table 2: Selection of Engineer Candidate

[N = 34]	Technical Candidate	Sociable Candidate
Attention to Human Relations Scores	8 (44%)	10 (56%)
Attention to Technical Knowledge Scores	11 (69%)	5 (31%)

Effect of Attentional Manipulation The direction of effects was consistent with Q1, however, the result only approached statistical significance, with χ^2 (1, N = 34) = 2.03, p = 0.08 (one-tailed). The non-significant outcome may be in part due to the small participant pool. [4]

[4] The data for the final 27 participants was lost due to errors with the database servers.

Question 3: Manager of Engineers

Based upon the *recall* and *reason* responses from Question 2, it was clear that many participants were treating the claim "technical knowledge is slightly more important than human relations" as justification for limiting the decision scope to technical knowledge alone. This trend was noticed in Question 1 as well, where many participants interpreted *performance* narrowly as referring to speed, and thereby based their decision disproportionately on car safety alone.

Question 3 attempted to curb this tendency by ensuring that both attributes were of equal importance, and a trade-off was required across attributes. The scenario from Q2 was modified into a choice between two managerial candidates, thereby increasing the natural importance of *human relations* candidate scores. In addition, the participants were told that "both attributes are very important." Finally, the difference between the two candidates' scores was made more extreme to increase the perceived difference between them.

> You are an executive of a company. You have to select between two candidates for the position of Manager of your Engineering Division. The candidates were scored on their technical knowledge and human relations on a scale from 40 (very weak) to 100 (superb). Both attributes are very important. On the basis of the following scores, which candidate would you choose?

	T. Knowledge	H. Relations
Candidate A	57	91
Candidate B	88	60

Effect of Attentional Manipulation There was a statistically significant effect of attentional manipulation on choice, χ^2 (1, N = 58) = 3.87, p = 0.02. As shown in Table 3, the effect of the attentional manipulation was similar to the effect of increased importance on the attended attribute.

Table 3: Selection of Manager of Engineering Division

[N = 58]	Technical Candidate	Sociable Candidate
Attention to Human Relations	10 (42%)	14 (58%)
Attention to Technical Knowledge	23 (67%)	11 (32%)

Attentional Effects across Questions

Given the consistency of results across Q1 – Q3, we examined the main effect of attention on choice behavior. To do so, we defined *Attribute 1* as the primary attribute in each question, (i.e. *safety* in Q1 and *technical knowledge* in Q2, 3). We defined *Attribute 2* as the secondary attribute in each question, (i.e. *performance* in Q1 and *human relations* in Q2 & Q3). Similarly, we defined *Option A* as the choice that is superior on the Attribute 1 (i.e. *safety car* in Q1; *technical candidate* in Q2 & Q3), and Option B as the choice that is superior on Attribute 2 (i.e. *performance car* in Q1; *sociable candidate* in Q2 & Q3). Using this scheme to collapse the data across Q1 – Q3, we found a highly significant effect of attention on choice in favor of the attended attribute, χ^2 (1, N = 149) = 9, p = 0.001 (one-tailed). See figure 3.

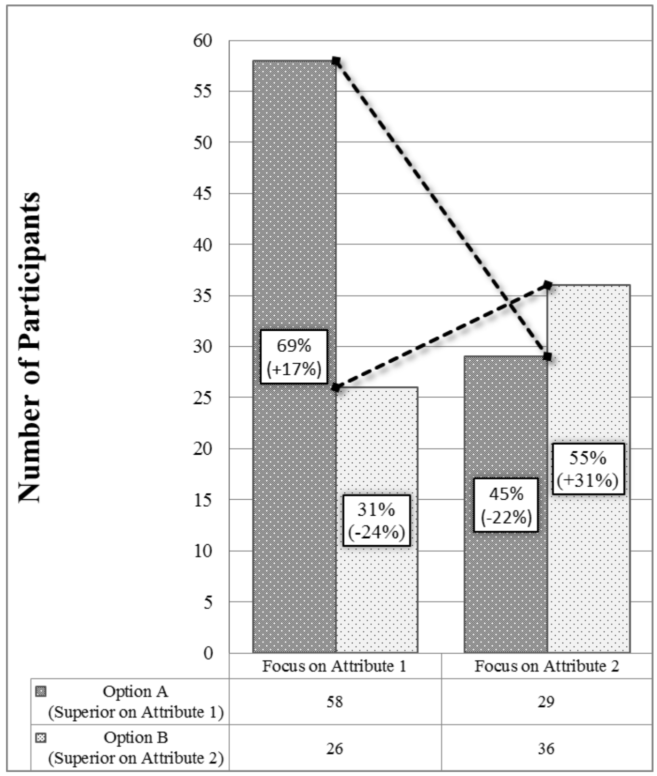

Figure 3: Main Effect of Attention on Choice Behavior

Discussion

For all decision scenarios presented here, we found a direct and positive relationship between the location of the memorized rectangle and the amount of influence accorded to the information presented at that location on screen. In Question 1, participants were asked to choose between two cars rated on their safety and performance. When the memorized location overlapped with the performance ratings, 52% selected the car that was superior on performance, whereas only 29% made the same choice when the memorized location overlapped with the safety ratings. Similarly, in Question 2 and Question 3, when choosing between two job candidates rated on technical knowledge and human relations, the majority of participants (69% in Q2 and 67% in Q3) preferred the technical candidate when the memorized location overlapped with the technical knowledge scores, but not when it overlapped with human relations scores (only 31% in Q2 and 32% in Q3). It is notable that the effects of attentional manipulation were remarkably consistent across the three decision scenarios.

These findings clearly demonstrate that the memory task was – presumably through attentional allocation – causing the participants to give that information greater influence in the decision process. For all three questions, the attentional manipulation increased the selection of the option that was superior in attended attribute. This pattern of results is most parsimoniously interpreted as a change in the weight associated with the different attributes.

While previous claims have been made in this regard (e.g. Carmon & Ariely, 2000; Weber & Kirsner, 1997), no previous study had directly manipulated attention with the express purpose of empirically verifying this relationship. Some previous work had manipulated attention by indirect techniques such as task (e.g. pricing vs. choosing, Tversky et al., 1988), adopted role (e.g. statistician vs. clinical psychologist, as cited in Kahneman & Frederick, 2002), pursuit of information (e.g., Bastardi & Shafir, 1998) et cetera. However, these studies face difficulties separating the effects of attention from other effects.

The experimental manipulation presented here minimized such externalities. It induced significant and systematic changes in choice preference without altering any aspects of the decision problem, the task instructions, or the techniques used to elicit the preference values. Moreover, the vast majority of participants remained unaware of the influence on their decision making process.

Conclusion

The current work presents a novel methodology to reliably and covertly manipulate the attention of an observer and direct that attention to specific components of a decision scenario. This methodology was deployed in the present work to empirically examine the relationship between attention and decision weight in a multi-attribute context.

It should be noted that although, in the scenarios chosen here, additional attention bestowed greater importance upon the attended attribute, there may be situations where the relationship does not hold (e.g. as claimed by Bastardi & Shafir, 1998; Bertini & Wathieu, 2008; Sherman et al., 2005). If so, the current design provides a systematic method to examine such exceptions to the oft-assumed direct, positive link between attention and importance.

Finally, the current work also reaffirms the unique potential of crowdsourcing psychological research, including studies that have various perceptual components. Although the data validity concerns and exclusion rates may be higher than expected at a physical lab, the current work confirms that a carefully designed system of precautions and catch mechanisms can be used to overcome these limitations and take advantage of this new and underutilized resource.

Acknowledgements

We would like to sincerely thank Emir Kamenica, Joshua Stevenson and Andres Millan for their assistance with the design, implementation, and manuscript, respectively.

References

Awh, E. & Jonides, J. (2001). Overlapping mechanisms of attention and spatial working memory. *Trends in Cognitive Science*, 5(3), 119 – 126.

Awh, E., Jonides, J., & Reuter-Lorenz, P.A. (1998). Rehearsal in Spatial Working Memory. Journal of Experimental Psychology: Human Perception and Performance. 24(3), 780-790.

Awh, E., Vogel, E. K., & Oh, S. H. (2006). Interactions between attention and working memory. *Neuroscience*, 139, 201-208.

Bastardi, A., & Shafir, E. (1998). On the pursuit and misuse of useless information. *Journal of Personality and Social Psychology*, 75, 1, 19-32.

Bertini, M., & Wathieu, L. (2008). Research Note--Attention Arousal Through Price Partitioning. *Marketing Science*, 27(2), 236-246.

Busemeyer, J. R. and J. G. Johnson (2008). Micro-process Models of Decision Making. R. Sun (Ed.) *Cambridge Handbook of Computational Cognitive Modeling*. Cambridge University Press, p. 302 – 322.

Carmon, Z. & Ariely, D. (2000), Focusing on the Forgone: How Value Can Appear So Different to Buyers and Sellers, *Journal of Consumer Research*, 27 (3), 360-370.

Downing, P. E. (2000). Interactions between visual working memory and selective attention. Psyc. Sci., 11, 467–473.

Horton, J. J., Rand, D. G. and Zeckhauser, R. J. (2010). The Online Laboratory: Conducting Experiments in a Real Labor Market (April 16, 2010). Available at SSRN: http://ssrn.com/abstract=1591202

Kahneman, D. & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. pp. 49-81 in T. Gilovich, D. Griffin, and D. Kahneman [eds]. *Heuristics & Biases: The Psychology of Intuitive Judgment*. New York. Cambridge University Press.

Paolacci, G., Chandler, J., and Ipeirotis, P. G. (2010). Running Experiments on Amazon Mechanical Turk. *Judgment and Decision Making*, 5(5), 411-419. Available at SSRN: http://ssrn.com/abstract=1626226

Sherman, J. W., Stroessner, S. J., Conrey, F. R., & Azam, O. (2005). Prejudice and stereotype maintenance processes: Attention, attribution, and individuation. Journal of Personality and Social Psych., 89, 607-622.

Soto, D., Hodsoll J., Rotshtein, P., & Humphreys G. W. (2008). Automatic guidance of attention from working memory. *Trends in Cognitive Science*, 12, 342-348.

Theeuwes J., Belopolsky A., Olivers C.N. (2009) Interactions between working memory, attention and eye movements. *Acta Psycholgica*.

Tversky, A., Sattath, S., & Slovic, P. (1988). Contingent weighting in judgment and choice. *Psychological review*, 95(3), 371 – 384.

Weber E. U. & Johnson, E. J. (2009). Mindful judgment and decision making. *Annual Review of Psyc.*, 60, 53 – 85.

Weber, E. U., & Kirsner, B. (1997). Reasons for Rank-Dependent Utility Evaluation. *Journal of Risk and Uncertainty*, 14(1), 41-61.